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ABSTRACT

A project developed and tested articulation and instructional models for an electronics program in secondary schools. Two nontraditional methods of instruction were used: (1) computer-assisted video and (2) video, laboratory, and recitation. Electronic theory was taught at the student's home high school; laboratory exercises were completed at centralized locations during the evening. Students earned Linn-Benton Community College (LBCC) credit for successfully completing all required activities. The outstanding accomplishment was the development and use of a process for articulation between LBCC and local high schools. The process resulted in a mutual risk/benefit model for articulation between high schools and a community college. Evaluation data collected from students, parents, instructors, and administrators indicated students progressed at varying rates; homework, instructors, and lab activities were the most helpful to students, videotapes and textbooks the least; students perceived reading materials as somewhat difficult to understand; most students indicated willingness to continue in the program; and instructors and administrators supported the project. (Appendixes, which comprise the major portion of this report, include the mutual risk/benefit model; student, instructor, and administrator critiques; parent survey; evaluation schedules and forms; and project-developed supplemental curriculum material--glossary, refresher workbooks on fractions, scientific notation, equation, and two-variable equations.) (YLB)

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FINAL REPORT

"THE NEW REA ----- RURAL ELECTRONICS ACCORD"

22-000-126

LINN-BENTON EDUCATION SERVICE
DISTRICT

905 4TH AVENUE, SE

ALBANY, OR 97321

CE043507

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JUNE 1985

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Appendix B1
(Completed by Project
Director/Principal
Investigator

ABSTRACT

A. PROJECT DESCRIPTION

1. Project Title: "THE NEW REA ---- RURAL ELECTRONICS ACCORD"

2. Principal Investigator and Organization: Wayne Johnson
Linn-Benton Education Service District
Address: 905 4th Avenue SE, Albany, OR 97321
Telephone: (503) 967-8822
Congressional District

3. Special Population Target Groups
Check Primary Group(s)

Racial/Ethnic

American Indian or Alaskan Native		Limited English Proficiency	
Asian or Pacific Islander		Handicapped	X
Black, Non-Hispanic		Disadvantaged	X
Hispanic		Displaced Homemaker	
White, Non-Hispanic		Single Head of Household	
Men	X	Part to Full-Time Employment	X
Women	X	Persons in Non-Traditional Vocations	
		Others	

4. Number of Students Affected 21; Number of Staff Affected 6

5. Project Objectives: Project goals were to: 1.0 Provide an electronics program at secondary schools, where one does not presently exist, through LBCC. 2.0 Expand the electronics program at secondary schools, where one currently exists, thru LBCC. 3.0 Improve the articulation between secondary school's and LBCC's electronics program. 4.0 Provide data on alternative approaches to electronics instruction.

6. Project Procedures. (Describe the processes to be used in implementing and evaluating this project):
Two "non-traditional" methods of instruction were used in the project: video, laboratory and recitation; and computer assisted video. Special low-level materials were developed and purchased. Ongoing evaluation was a part of the project.

7. Project Products:

A mutual risk/benefit model for articulation. A strategy for teaching electronics using the model.

8. Expected Contribution or Potential Impact on Vocational Education:

The project provides electronics instruction where it formerly did not exist. It is serving as a model for other areas. A second electronics course will be added this Fall (1985).

9. Will the product be placed in a classroom within your district in the five years?
It is in place at six high schools.
X Yes ____ No

GUIDE TO REPORT

II. Body of the Final Report

III. Budget/Spend-Out Report

IV. Appendices

A. Mutual Risk/Benefit Model

B. Student Characteristics

C. Student End of Year Critique

D. Parent Survey

E. Instructor Critique

F. Administrator Critique

G. Evaluation (Schedule(s), Forms)

H. Supplemental Curriculum Material (Project Developed)

PROJECT TITLE: The New REA--Rural Electronics Accord.

PROJECT NUMBER: 22-000-126

AGENCY: Linn-Benton Education Service District
905 4th Avenue,S.E.
Albany OR 97321

BACKGROUND:

The State of Oregon has focused on high technology industries as a means for diversifying and developing its economy. The electronics industry has been in the forefront of the State's economic development effort. The availability of a trained work force is a key factor to attracting the electronics industry. However, resources available to prepare productive workers are scarce. In the high school, vocational programs are electives. Increased academic requirements for graduation and for entry into post-secondary education affect the time and resources available for elective programs. The resources and students available in a single community and its educational institutions may not be sufficient to provide effective education and training in electronics. However, the project demonstrated that the pooling of resources in a region can provide sufficient materials, expertise, facilities and students to do so.

Electronics instruction provided by the project is adaptable to any high school situation. Electronic theory is taught in the student's home high school through a variety of means, including videotapes, guided readings in textbooks, and homework assignments. Supplemental materials reinforce or provide assistance for student learning. Laboratory exercises, including the preparation of reports, are completed at centralized locations during the evening. Students earn Linn-Benton Community College credit for successfully completing all required activities. Computer-assisted video instruction (CAVI)

developed by San Mateo Community College was used as an alternative means of instruction during one term at Lebanon High School.

The most important outcome of the project was the development and testing of a mutual risk/benefit model for articulation between high schools and a community college. In this model, each participant assumes a portion of the responsibility for enabling the instructional process to succeed but receives sufficient benefits to overshadow the inherent risks. The risks and benefits for students, high schools, and the community college are outlined in Appendix A.

Six high schools, Linn-Benton Community College and Linn-Benton Education Service District were the key participants in developing and testing the articulation and instructional models. The effort enabled Corvallis High School, Crescent Valley High School, Lebanon High School, South Albany High School, and West Albany High School to expand their electronics offerings. Philomath High School was able to offer electronics education to its students for the first time. Hewlett-Packard's Corvallis Division and White's Electronics in Sweet Home advised the project staff on and supported the models. Given greater time, participation by industry and high schools without electronics instruction could have been increased.

Students were able to begin participation during any term and could progress at their own learning rate. Twenty-one students participated in the project, but background data are available on only 20. Ten students participated in all three terms of the project, seven students were able to participate in two terms of instruction, and two started their electronics instruction during Spring term. Two students (10%) started but did not complete

the first term of instruction. Three of the 20 students were female; one additonal female student did not provide background data. Six of the students did not have prior instruction in electronics. Ten students were seniors, eight were juniors, and two were sophomores. Additional characteristics of the students are described in Appendix B.

A set of the CAVI electronics materials developed by OPEP were field tested under the auspices of this project at the Children's Farm Home School in Corvallis. The four students who participated in the field test responded very favorably to the electronics material and means of instruction.

In addition to the materials provided in the Appendices, a videotape of students and instructors who participated in the project was developed. A copy of the videotape is being provided under separate cover.

MAJOR ACCOMPLISHMENTS AND OUTCOMES:

The outstanding accomplishment of the project was the development and use of a process for articulation between Linn-Benton Community College and local high schools. The process resulted in the mutual risk/benefit model described in Appendix A. Application of the model focuses on the collaborative efforts of an ESD and a community college to guide the progressive involvement and commitment by school administrators, teachers, students and parents. Because of tight timelines inherent to the funding of the project, the bulk of the effort was spent on acquiring the commitment of teachers and students. This was necessary to get the instruction in place for implementation by the start of the 1984-85 school year. Furthermore, the instructors assumed "ownership" of the project--the key to its success. Additional evidence of this ownership is their

commitment to continue the first year's DC theory instruction and to implement the second course, AC theory, during the 1985-86 school year.

An articulated computer science course based on the mutual risk/benefit model will be implemented during Fall 1985. Additional work is being done in drafting and agriculture, and the application of the model is being explored in other areas. These efforts are a direct off-shoot of the electronics project and are being accomplished with local resources. Although implemented in Linn and Benton Counties, the model is currently being used to extend the electronics courses to Lincoln County's high schools.

Based on the accomplishments of this project, the Oregon Department of Education funded a sex-equity project to recruit non-traditional students into programs leading towards employment in high technology occupations. The companion project was based on this project's experiences with recruiting non-traditional students into the electronics program and lead to the involvement of Lincoln County.

Through the project, LBCC course material was adapted to fit the high school schedule. Lecture material is delivered via videotape; reading and homework assignments are outlined for the student. This allows the student to manage their own instruction. A responsible adult at the high school should be available to check out the videotapes and to assure that students are on task. This person need not hold a teaching certificate. Linn-Benton Community College owns the copyright to the tapes, which were produced by Texas Instruments, so the cost of reproduction is minimal.

The mutual risk/benefit model was tentatively tested for providing electronics instruction to employees of electronic companies. White's

Electronics in Sweet Home agreed to provide facilities and an instructor for the laboratory portion of the program. Students at Sweet Home High School would have participated in the self-directed theory instruction at the high school and in the laboratory activities at White's Electronics. The project was not able to generate sufficient enrollment at Sweet Home High School. White's had identified employees to participate in the project, but economic conditions prevented implementation of the program.

Several electronics firms were approached and were favorable to offering summer internships to select graduating seniors who had participated in the project. Linn-Benton Community College's Cooperative Work Experience Program was prepared to manage the internships. A planned series of instruction and interviews were developed to facilitate placements. Economic conditions faced by the electronics industry prevented fruition of this activity. However, the potential still exists for these internships when conditions improve.

PROBLEMS:

As discussed earlier, most of the available time for implementing the program was spent with teahers and students. More time was needed to gain formal adoption of the mutual risk/benefit concept as a general means for articulation. This work will continue in 1985-86.

A major finding of this project was that the participating high school students did not react favorably to the San Mateo CAVI system. Part of the deficiency was the availability of only one set of hardware for eight students during the school day. More critical, however, was the lack of depth of instruction on DC theory that was needed by students to accomplish prescribed

goals of the LBCC program. The CAVI materials may have been sufficient if additional applications of theory and instruction on network theorems were available. Students also reacted negatively to the computer's response time and to the quality of the videotapes.

Recruitment of students for participation in the electronics program should have begun the year prior to the first term of instruction. The relatively low enrollment in this project was due to the late starting date of the project. Relatively low participation by non-traditional students should be rectified by the outputs of the companion sex-equity project. The level of electronics instruction emphasized by this project did not lend itself to academically disadvantaged or mentally handicapped students. The time available for instructional development permitted the adaption of existing materials, minimal new materials development, and the focus on only the electronic technician occupations. The OPEP materials can be used in recruitment and serve as the reason for remedial instruction in reading, science and mathematics for those who would not normally participate in the program.

Very little can be said at this time about the impact of the instruction on students. The second year of instruction, which is currently being developed and will be implemented next year, as well as sufficient time to follow-up on completers of the entire program is needed for these kinds of evaluative findings. As will be discussed in the next section, student achievement appeared to be satisfactory and the instructional process was well received by students, their parents, and the instructors.

For students in schools without approved vocational electronics programs, laboratory meetings served as the only time for instructor contact. However,

this was not always timely for questions that students had about their in-school and homework. The use of the telephone and a means for graphic communication, such as a microcumpter with a modem, shows promise as a means to overcome the problem. This method as well as alternative ones need further testing.

The project was not able to acquire official ODE approval of the electronics instruction received by the students at the high school without an approved vocational electronics program. Greater flexibility may be needed in the program approval process to encourage schools without approved clusters to participate in articulated efforts. Lack of flexibility could stifle efforts to increase the opportunities for students to benefit from instruction which their home schools cannot normally provide.

EVALUATION:

A variety of evaluative data were collected from students, their parents, instructors and administrators throughout the duration of the project. The numbers of participants were too small for definitive findings on both the process and outcomes of the project. However, available data seems to indicate the following:

1. Students progressed at varying rates. The average earned community college grade was 3.0 (B). The students felt that the overall difficulty of the instruction was "just right." It should be noted that they viewed the fifth and six laboratory exercises as "difficult" to accomplish. Perhaps the transitions between labs 4 and 5 and between 5 and 6 could be improved. Students reported that the homework, instructors and lab activities were the most helpful to them.

Videotapes and textbooks were the least helpful. The reading materials were perceived as somewhat difficult to understand. Solving the mathematical problems did not appear to pose any unusai difficulty. However, the three students who had scored the lowest on the pretest reported difficulties with solving the mathematics problems. All participants were enrolled in or had completed at least algebra, and 80 percent were enrolled in or had completed geometry.

2. Most of the students indicated that they would be willing to continue in the program and would encourage their friends to participate, also. Students and parents reported that the evening laboratory was acceptable most of the time. Transportation and traveling time for the evening activity were not considered problems. Both parents and students said that the LBCC credit was important. Parents were highly enthusiastic with the electronics program and indicated that they wanted more like it in other subject areas. They would also encourage their children to participate in additional electronics instruction even with the same schedule.
3. Instructors were generally enthusiastic about the project. They felt that the instruction was more appropriate for the more able students than the less able ones. Administrators supported the project and would like to see their districts participate in similar advanced placement efforts in such areas as science, mathematics, and foreign languages.

SUMMARY AND CONCLUSIONS:

The mutual risk/benefit model for articulation between high schools and their community college is a viable means for collaborative efforts. Participants must clearly see that benefits outweigh the risks, including costs. The education service district, as a neutral party, must actively promote and facilitate the process. Both community college and high school instructors must assume "ownership" of the effort. Students need timely and sufficient information in order to judge the benefits of their participation. The model appears to be generalizable to other subject areas. Early adoption of the model by chief school administrators will facilitate the initial as well as follow-on efforts at articulation.

RECOMMENDATIONS:

The mutual risk/benefit model should be adopted by other education service districts to implement collaborative efforts between high schools and colleges. Annual seed money would facilitate sustained application of the model.

PROJECT FOLLOW-UP AND COMMITMENT:

The DC theory course is under revision and will again be offered during the 1985-86 school year. In addition, the AC theory course is currently being adapted and is scheduled for implementation this Fall. As mentioned previously, articulated instruction in computer science is also being offered this Fall. Planning is underway to expand the application of the mutual risk/benefit model into drafting and agriculture.

III. BUDGET/SPEND-OUT REPORT

County Linn-Benton District ESD

Part 1 of 6

REA FINAL BUDGET REPORT

Program No. 360.11 Encumbrance No. 22-000-126 Amount of Part 1 $31,000.

SPECIAL PROJECT BUDGET	FEDERAL/STATE FUNDS RECEIVED	ACTUAL EXPENDITURES
1000 Instruction		
100 Salaries		
200 Employee Benefits		
300 Travel	$ 1,000	$ 1,755.86
Other Purchased Services	8,411	18,322.94
400 Supplies	5,400	3,292.34
500 Equipment	13,400	4,839.86
2210 Improvement of Instructional Services		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services		
400 Supplies		
500 Equipment		
2220 Educational Media Services		
100 Salaries		
200 Employee Benefits		
300 Purchased Services		
400 Supplies		
500 Equipment		
2500/2600 Support Services Business/Central Indirect Cost @ 9.9 %	2,789	2,789.00
TOTAL	$ 31,000	$ 31,000.00

County Linn-Benton District ESD

Part 2 of 6

REA FINAL BUDGET REPORT

Program No. 360.12 Encumbrance No. 22-000-126 Amount of Part 2 $ 3,130

SPECIAL PROJECT BUDGET	FEDERAL/STATE FUNDS RECEIVED	ACTUAL EXPENDITURES
1000 Instruction		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services	1,693	1,693.00
400 Supplies	1,155	1,155.00
500 Equipment		
2210 Improvement of Instructional Services		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services		
400 Supplies		
500 Equipment		
2220 Educational Media Services		
100 Salaries		
200 Employee Benefits		
300 Purchased Services		
400 Supplies		
500 Equipment		
2500/2600 Support Services Business/Central Indirect Cost @ 9.9 %	282	282.00
TOTAL	3,130	3,130.00

County Linn-Benton District ESD

Part 3 of 6

REA FINAL BUDGET REPORT

Program No. 360.13 Encumbrance No. 22-000-126 Amount of Part 3 $ 5,870

SPECIAL PROJECT BUDGET	FEDERAL/STATE FUNDS RECEIVED	ACTUAL EXPENDITURES
1000 Instruction		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services		
400 Supplies	2,996	2,996.00
500 Equipment	2,345	2,345.00
2210 Improvement of Instructional Services		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services		
400 Supplies		
500 Equipment		
2220 Educational Media Services		
100 Salaries		
200 Employee Benefits		
300 Purchased Services		
400 Supplies		
500 Equipment		
2500/2600 Support Services Business/Central Indirect Cost @ 9.9 %	529	529.00
TOTAL	5,870	5,870.00

County Linn-Benton District ESD

Part 4 of 6

REA FINAL BUDGET REPORT

Program No. 361.31 Encumbrance No. 22-000-126 Amount of Part 4 $ 4,000

SPECIAL PROJECT BUDGET	FEDERAL/STATE FUNDS RECEIVED	ACTUAL EXPENDITURES
1000 Instruction		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services		
400 Supplies		
500 Equipment		
2210 Improvement of Instructional Services		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services	3,640	3,640.00
400 Supplies		
500 Equipment		
2220 Educational Media Services		
100 Salaries		
200 Employee Benefits		
300 Purchased Services		
400 Supplies		
500 Equipment		
2500/2600 Support Services Business/Central Indirect Cost @ 9.9 %	360	360.00
TOTAL	4,000	4,000.00

County Linn-Benton District ESD

Part 5 of 6

REA FINAL BUDGET REPORT

Program No. 361.32 Encumbrance No. 22-000-126 Amount of Part 5 $ 1,740

SPECIAL PROJECT BUDGET	FEDERAL/STATE FUNDS RECEIVED	ACTUAL EXPENDITURES
1000 Instruction		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services		
400 Supplies		
500 Equipment		
2210 Improvement of Instructional Services		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services	1,584	1,584.00
400 Supplies		
500 Equipment		
2220 Educational Media Services		
100 Salaries		
200 Employee Benefits		
300 Purchased Services		
400 Supplies		
500 Equipment		
2500/2600 Support Services Business/Central Indirect Cost @ 9.9 %	156	156.00
TOTAL	1,740	1,740.00

County Linn-Benton District ESD

Part 6 of 6

REA FINAL BUDGET REPORT

Program No. 361.33 Encumbrance No. 22-000-126 Amount of Part 6 $ 4,260

SPECIAL PROJECT BUDGET	FEDERAL/STATE FUNDS RECEIVED	ACTUAL EXPENDITURES
1000 Instruction		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services		
400 Supplies		
500 Equipment		
2210 Improvement of Instructional Services		
100 Salaries		
200 Employee Benefits		
300 Travel		
Other Purchased Services	3,876	3,876.00
400 Supplies		
500 Equipment		
2220 Educational Media Services		
100 Salaries		
200 Employee Benefits		
300 Purchased Services		
400 Supplies		
500 Equipment		
2500/2600 Support Services Business/Central Indirect Cost @ 9.9 %	384	384.00
TOTAL	4,260	4,260.00

APPENDIX A

MUTUAL RISK/BENEFIT MODEL

LINN-BENTON COMMUNITY COLLEGE AND
LINN-BENTON EDUCATIONAL SERVICE DISTRICT
MUTUAL RISK/BENEFIT MODEL ANALYSIS

Agent	Risks	Benefits
High School student	a) Lab work outside usual school day b) Minimal support system c) Transportation d) Another activity added on	a) College credits b) College experience with expected maturity c) Summer internship possibility d) career opportunities
Parent	a) Financial (1/2 tuition) b) Transportation c) Student's additional outside commitment	a) Offspring have realistic low cost college experience b) Career opportunities for offspring
High School Instructors	a) Extra paperwork b) Additional student load	a) Possible part-time teaching and CWE work b) Attract "college" track students into tech classes c) Closer relationships with college staff
Business	a) Time spent working with students, serving on advisory committee, donating equipment.	a) Pool of interested employees with some skill b) Public relations c) Interaction of company with college and secondary schools
LBCC	a) Low enrollment lab classes with part-time instructors b) High intensity paper-work and student tracking	a) Cooperation between faculties b) Increased pool of possible curriculum majors c) Some tuition and FTE d) Public relations e) Low cost flexible delivery
Secondary schools	a) Moderate cost in texts and video materials b) Need for standard video equipment and micro-computers	a) Curriculum offerings not before available to small numbers of students b) Faculty upgrading and morale c) Possible equipment and materials enhancement d) Low cost flexible delivery

APPENDIX B

STUDENT CHARACTERISTICS

New REA Project Form 1

BACKGROUND SURVEY

1. What is your sex?

a. Female.	2
b. Male.	18

2. How old are you?

a. Less than 14 years.	0
b. 14 years old.	0
c. 15 years old.	1
d. 16 years old.	11
e. 17 years old.	7
f. 18 years old.	1
g. 19 years old.	0
h. Older than 19 years.	0

3. What grade are you in now?

a. 9th grade.	0
b. 10th grade.	2
c. 11th grade.	8
d. 12th grade.	10
e. Others (Please specify). _____	

4. Have you completed or are you now enrolled in any of the following courses?

4.1 Algebra.

a. Completed.	16
b. Taking now.	4
c. Never.	0

4.2 Geometry.

a. Completed.	14
b. Taking now.	2
c. Never.	4

4.3 Trigonometry.

a. Completed.	2
b. Taking now.	5
c. Never.	13

4.4 Physics.

a. Completed.	1
b. Taking now.	6
c. Never.	13

4.5 Chemistry.

a. Completed.	7
b. Taking now.	4
c. Never.	9

4.6 Electronics (other than this class).

a. Completed.	10
b. Taking now.	6
Never.	4

5. Have you ever worked on an electronics project or use electronics testing equipment (i.e., VOM, Oscilloscope)?

a. No.	3
b. 1 or 2 times.	9
c. Several times.	0
d. Very often.	8

6. Have you ever used computers, including microcomputers?

a. Never.	5
b. Only a few times.	4
c. Many times, but still do not feel comfortable with them.	1
d. Many times and feel very comfortable with them.	10

7. Have you written computer programs?

a. No.	6
b. Yes, one or two.	1
c. Yes, a few.	4
d. Yes, a lot of them.	9

APPENDIX C

STUDENT END OF YEAR CRITIQUE

New REA Project Form 10

STUDENT END OF YEAR CRITIQUE

1. How many terms have you compeleted in the program?

1.	three (fall, winter, spring).	8
2.	two (winter and spring).	7
3.	one (spring only).	

2. Overall, how difficult or easy to learn were the theories or ideas in this course? (Circle one letter only)

1.	very easy.	0	Mean = 4.1
2.	easy.	2	S.D. = 1.2
3.	somewhat easy.	2	
4.	just right.	5	
5.	somewhat difficult.	4	
6.	difficult.		
7.	very difficult.	0	

3. Overall, how fast or slow was the instruction in this course?

1.	very fast.	1	Mean = 4.3
2.	fast.	0	S.D. = 1.3
3.	somewhat fast.	3	
4.	just right.	3	
5.	somewhat slow.	6	
6.	slow.	2	
7.	very slow.	0	

4. Overall, which one of the following was most helpful to you for learning about electricity theories or ideas?

1.	textbook.	0
2.	homework problems.	6
3.	lab activities.	4
4.	instructor.	5
5.	video-tapes.	0
6.	CAVI or computer assisted video instruction (Lebanon only).	0
7.	other. (Please indicate: _____)	

5. Overall, which one of the following was the least helpful to you for learning about electricity theories or ideas in this course?

1.	textbook.	3
2.	homework problems.	4
3.	lab activities.	1
4.	instructor.	0
5.	video-tapes.	3
6.	CAVI or computer assisted video instruction (Lebanon only).	2
7.	none; they were all helpful	2

6. How easy or difficulty was it to understand the written materials (textbooks, handouts, lab manuals)?

1. very easy.	0	Mean = 4.3
2. easy.	0	S.D. = 0.9
3. somewhat easy.	4	
4. just right.	3	
5. somewhat difficult.	8	
6. difficult.	0	
7. very difficult.	0	

7. How easy or difficult was it to solve the mathematics problems?

1. very easy.	2	Mean = 3.6
2. easy.	2	S.D. = 1.7
3. somewhat easy.	5	
4. just right.	0	
5. somewhat difficult.	4	
6. difficult.	1	
7. very difficult.	1	

8. How easy or difficult was it to write the laboratory reports?

1. very easy.	1	Mean = 3.9
2. easy.	2	S.D. = 1.5
3. somewhat easy.	4	
4. just right.	1	
5. somewhat difficult.	5	
6. difficult.	2	
7. very difficult.	0	

9. In this program, lab activities were held during the evenings. Was this okay?

1. great.	5	Mean = 2.1
2. okay most of the time.	5	S.D. = 0.9
3. okay some of the time.	4	
4. I didn't like it.	1	
5. terrible.	0	

10. How much time did it take to get to the evening lab activity?

_____ minutes one way. Mean = 13.6; S.D. = 7.8

11. How important was earning Linn-Benton Community College credit to you?

1. very important.	5
2. important.	3
3. somewhat important.	5
4. neither important nor unimportant.	1
5. somewhat unimportant	0
6. unimportant.	1
7. very unimportant.	0

12. When you complete high school, what do you think you will be doing?

1.	enrolling in a 4-year university in electronics.	3
2.	enrolling in a 4-year university but in an area not related to electronics.	2
3.	enrolling in a community college in electronics.	6
4.	enrolling in a community college but in an area not related to electronics.	0
5.	working in electronics.	1
6.	working in an area not related to electronics.	0
7.	enlisting in a military service.	3
8.	unsure of what you will be doing.	0

13. Would you encourage friends or classmates to enroll in this program next year if they asked you about it?

1.	yes, very much so.	7	Mean = 1.9
2.	yes.	5	S.D. = 1.2
3.	yes, but with some hesitation.	1	
4.	maybe.	1	
5.	no.	1	

14. If we offered additional electronics instruction with the same schedule and instructional method in the future, would you enroll in it?

1.	yes, very much so.	8	Mean = 2.0
2.	yes.	3	S.D. = 1.3
3.	yes, but with some hesitation.	1	
4.	may be.	2	
5.	no.	1	

15. How could we interest your classmates in enrolling in this program? (Circle <u>all</u> that apply.)

1.	provide better information on the program.	9
2.	provide better information on job and educational options which could result from the program.	9
3.	provide information on the program earlier.	9
4.	change the school schedule so that more students can take advanced electronics.	6
5.	change lab schedule for the program.	0
6.	get students who influence other students to enroll in the program.	1
7.	other (please provide your ideas):	

APPENDIX D

PARENT SURVEY

New REA Project Form 11

PARENT SURVEY

1. How many terms did your son/daughter participate in the program?

1.	three (fall, winter, spring).	7
2.	two (winter and spring).	3
3.	one (spring only).	1
4.	I am not sure.	1

2. What is your overall impression of the program? (Circle one letter only)

1.	great, there ought to be more programs like this one.	9	Mean = 1.4
2.	good, but some minor improvements are needed.	1	S.D. = 0.9
3.	fair, because minor improvements are needed.	0	
4.	marginal, because major improvements are needed.	1	
5.	poor, the program should not be offered again.	0	

3. In this program, lab activities were held during the evenings. Was this okay?

1.	great.	4	Mean = 1.7
2.	okay most of the time.	8	S.D. = 0.5
3.	okay some of the time.	0	
4.	I didn't like it.	0	
5.	terrible.	0	

4. How important was your son/daughter's earning of Linn-Benton Community College credit to him/her?

1.	very important.	5	Mean = 1.8
2.	important.	6	S.D. = 0.8
3.	somewhat important.	0	
4.	neither important nor unimportant.	1	
5.	somewhat unimportant	0	
6.	unimportant.	0	
7.	very unimportant.	0	

5. Was the cost for your son/c[illegible]er to participate in the program acceptable to you?

1.	very expensive.	0	Mean = 4.3
2.	expensive.	0	S.D. = 1.0
3.	somewhat expensive.	1	
4.	about right.	9	
5.	somewhat inexpensive.	1	
6.	inexpensive.	1	
7.	very inexpensive.	0	

6. To what extent did you understand the purposes and how instruction would be offered when you were first informed about the electronics project?

1. very clear understanding.	2	Mean = 2.4
2. clear understanding.	6	S.D. = 1.1
3. somewhat clear understanding.	1	
4. somewhat unclear understanding.	1	
5. unclear understanding.	1	
6. very unclear understanding.	0	

7. Would you encourage other parents/guardians to have their sons/daughters enroll in this program next year if they asked you about it?

1. yes, very much so.	7	Mean = 1.6
2. yes.	4	S.D. = 0.9
3. yes, but with some hesitation.	0	
4. maybe.	1	
5. no.	0	

8. If we offered additional electronics instruction with the same schedule and instructional method for your son/daughter in the future, would you encourage him/her to participate in it?

1. yes, very much so.	7	Mean = 1.7
2. yes.	4	S.D. = 1.1
3. yes, but with some hesitation.	0	
4. may be.	0	
5. no.	1	

APPENDIX E

INSTRUCTOR CRITIQUE

New REA Project Form 8

INSTRUCTOR CRITIQUE

1. Which of the following responsibilities did you have in the project:

1.	Electronics theory instructor.	1
2.	Laboratory instructor.	1
3.	Both theory and lab instructor.	4

2. Looking back to when you were first introduced to the New Rural Electronics Accord Project, did you understand the goals for the project and what you were getting involved with?

1.	yes, very much so.	2	Mean = 2.0
2.	yes.	2	S.D. = 0.8
3.	yes, somewhat	2	
4.	marginally.	0	
5.	no.	0	

3. Considering the workshops, briefings and/or printed materials, was the information on what was expected of you sufficient for you to function effectively?

1.	excellent.	1	Mean = 2.0
2.	good.	4	S.D. = 0.6
3.	adequate.	1	
4.	marginal.	0	
5.	inadequate.	0	

4. How difficult or easy was it to use the instructional schedules?

1.	very easy.	1	Mean = 2.3
2.	easy.	2	S.D. = 0.8
3.	somewhat easy.	3	
4.	marginal.	0	
5.	somewhat difficult.	0	
6.	difficult.	0	
7.	very difficult.	0	

5. How difficult or easy was it for you to implement and manage the instruction (including materials) in the New REA Project?

1.	very easy.	1	Mean = 2.5
2.	easy.	3	S.D. = 1.3
3.	somewhat easy.	1	
4.	marginal.	0	
5.	somewhat difficult.	1	
6.	difficult.	0	
7.	very difficult.	0	

6. Did you have to "motivate" the students who participated in the New REA Project to complete the instructional materials for which you were responsible?

1. yes, very much so.	1	Mean = 3
2. yes, somewhat.	1	S.D. = 1.2
3. yes, occassionally.	1	
4. yes, but very infrequently.	3	
5. no.	0	

7. Did you experience any difficulty with any of instructional materials that were developed specifically for the New REA Project (including technical accuracy, editing, and readability)?

1. yes, considerable.	0	Mean = 3.3
2. yes, somewhat.	1	S.D. = 0.8
3. yes, occassionally.	2	
4. yes, but very infrequently.	3	
5. no.	0	

8. Were textbooks, materials and equipment delivered to you when you needed them?

1. yes, all of the time.	3	Mean = 1.5
2. yes, most of the time.	3	S.D. = 0.5
3. yes, some of the time.	0	
4. yes, occassionally.	0	
5. no.	0	

9. What was the quality of the materials, including textbooks?

1. excellent.	2	Mean = 1.7
2. good.	4	S.D. = 0.5
3. adequate.	0	
4. marginal.	0	
5. inadequate.	0	

10. What was the quality of the equipment?

1. excellent.	1	Mean = 2.3
2. good.	2	S.D. = 1.1
3. adequate.	0	
4. marginal.	1	
5. inadequate.	0	

11. How responsive (flexible, supplemental activities, alternative goals, etc.) was the program (materials, equipment, schedule, etc.) to the bright student?

1. very responsive.	4	Mean = 1.3
2. responsive.	2	S.D. = 0.5
3. somewhat responsive.	0	
4. somewhat unresponsive.	0	
5. unresponsive.	0	
6. unresponsive.	0	

12. How responsive was the program to the lower ability student?

1. very responsive.	0	Mean = 3.2
2. responsive.	2	S.D. = 1.2
3. somewhat responsive.	1	
4. somewhat unresponsive.	1	
5. unresponsive.	1	
6. very unresponsive.	0	

13. Do you believe that your administrators supported (and not only by what they said to you) the New Rural Electronics Accord Project?

1. yes, very much so.	1	Mean = 2.3
2. yes.	2	S.D. = 0.8
3. yes, somewhat.	3	
4. no.	0	

14. Overall, how well did the New Rural Electronics Accord Project prepare students in electronics?

1. excellent.	2	Mean = 1.7
2. good, a few refinements needed.	4	S.D. = 0.5
3. fair, some modifications needed.	0	
4. marginal, many modifications needed.	0	
5. poor.	0	

15. Would you be willing to participate again in the first year of electronics instruction (DC theory) if it were offered next year (assuming appropriate modifications were made)?

1. strongly agree.	5	Mean = 1.2
2. agree.	1	S.D. = 0.4
3. somewhat agree.	0	
4. neither agree to disagree.	0	
5. somewhat disagree.	0	
6. disagree.	0	
7. strongly disagree.	0	

16. Would you be willing to participate in a second year of electronics instruction (AC theory) if it were available?

1.	strongly agree.	4	Mean = 1.3
2.	agree.	2	S.D. = 0.5
3.	somewhat agree.	0	
4.	neither agree nor disagree.	0	
5.	somewhat disagree.	0	
6.	disagree.	0	
7.	strongly disagree.	0	

17. Based on your experience with this project, are you more willing and able to advise your students on LBCC and its programs? (for high school instructors, only.)

1.	I was doing it before the project and will continue to do so.		5
2.	much more willing now.		1
3.	somewhat willing.	Mean = 1.2	0
4.	no.	S.D. = 0.4	0

BEST COPY AVAILABLE

APPENDIX F

ADMINISTRATOR CRITIQUE

New REA Project Form 9

ADMINISTRATOR CRITIQUE

1. Looking back to when you were first introduced to the New Rural Electronics Accord Project, did you understand the goals for the project and what you were getting involved with?

1. yes, very much so.	0	Mean = 2.0
2. yes.	4	S.D. = 0
3. yes, somewhat	0	
4. marginally.	0	
5. no.	0	

2. Considering the workshops, briefings and/or printed materials, was the information on what was expected of you sufficient for you to function effectively?

1. excellent.	1	Mean = 2.0
2. good.	2	S.D. = 0.7
3. adequate.	1	
4. marginal.	0	
5. inadequate.	0	

3. How difficult or easy was it for you to implement and manage the instruction (including materials) in the New REA Project?

1. very easy.	0	Mean = 2.3
2. easy.	3	S.D. = 0.4
3. somewhat easy.	1	
4. marginal.	0	
5. somewhat difficult.	0	
6. difficult.	0	
7. very difficult.	0	

4. Did you have to "motivate" your instructor who participated in the New REA Project?

1. yes, very much so.	0	Mean = 4.7
2. yes, somewhat.	0	S.D. = 0.5
3. yes, occassionally.	0	
4. yes, but very infrequently.	1	
5. no.	2	

5. Were textbooks, materials and equipment delivered to your school when they were needed?

1. yes, all of the time.	2	Mean = 1.5
2. yes, most of the time.	2	S.D. = 0.5
3. yes, some of the time.	0	
4. yes, occassionally.	0	
5. no.	0	

6. What was the quality of the materials, including textbooks?

1. excellent.	2	Mean = 1.5
2. good.	2	S.D. = 0.5
3. adequate.	0	
4. marginal.	0	
5. inadequate.	0	
6. no opinion.	0	

7. What was the quality of the equipment?

1. excellent.	3	Mean = 1.3
2. good.	1	S.D. = 0.4
3. adequate.	0	
4. marginal.	0	
5. inadequate.	0	
6. no opinion.	0	

8. How responsive (flexible, supplemental activities, alternative goals, etc.) was the program (materials, equipment, schedule, etc.) to the <u>bright</u> student?

1. very responsive.	1	Mean = 2.3
2. responsive.	2	S.D. = 1.1
3. somewhat responsive.	0	
4. no opinion.	1	
5. somewhat unresponsive.	0	
6. unresponsive.	0	
7. very unresponsive.	0	

9. How responsive was the program to the <u>lower ability</u> student?

1. very responsive.	0	Mean = 4.0
2. responsive.	0	S.D. = 0.7
3. somewhat responsive.	1	
4. no opinion.	2	
5. somewhat unresponsive.	1	
6. unresponsive.	0	
7. very unresponsive.	0	

10. Overall, how well did the New Rural Electronics Accord Project prepare students in electronics?

1. excellent.	0	Mean = 2.0
2. good, a few refinements needed.	4	S.D. = 0
3. fair, some modifications needed.	0	
4. marginal, many modifications needed.	0	
5. poor.	0	
6. no opinion.	0	

11. Would you be willing to participate again in the first year of electronics instruction (DC theory) if it were offered next year (assuming appropriate modifications were made)?

1. strongly agree.	3	Mean = 1.3
2. agree.	1	S.D. = 0.4
3. somewhat agree.	0	
4. neither agree to disagree.	0	
5. somewhat disagree.	0	
6. disagree.	0	
7. strongly disagree.	0	

12. Would you be willing to participate in a second year of electronics instruction (AC theory) if it were available?

1. strongly agree.	2	Mean = 1.8
2. agree.	1	S.D. = 0.8
3. somewhat agree.	1	
4. neither agree nor disagree.	0	
5. somewhat disagree.	0	
6. disagree.	0	
7. strongly disagree.	0	

13. Overall, did the project adequately articulate high school and community college instruction?

1. strongly agree.	2	Mean = 1.5
2. agree.	2	S.D. = 0.5
3. somewhat agree.	0	
4. neither agree nor disagree.	0	
5. somewhat disagree.	0	
6. disagree.	0	
7. strongly disagree.	0	

14. Please rate the quality of the guidance information provided by the project to interest students in participating in the New REA Project.

1. excellent.	0	Mean = 2.8
2. good.	2	S.D. = 0.8
3. adequate.	1	
4. marginal.	1	
5. inadequate.	0	

15. If your district needed to purchase replacement books, materials and supplies, would you be willing to recommend to your administrators that your high school(s) should continue its/their participation in the New REA Project?

1. yes, even if it meant reallocation of vocational resources.		2
2. yes, only if funds were provided.		2
3. maybe.	Mean = 1.5	0
4. no.	S.D. = 0.5	0

16. Would you like to participate in similar efforts for other vocational areas (e.g., mechanics, agriculture, business)?

1. very much so.	4	Mean = 1.0
2. yes.	0	S.D. = 0
3. maybe.	0	
4. no.	0	

17. Would your district participate in similar efforts in academic areas?

1. very much so.	1	Mean = 2.0
2. yes.	2	S.D. = 0.7
3. maybe.	1	
4. no.	0	

APPENDIX G

EVALUATION

- Schedule(s)

- Forms

New REA Project

DATA COLLECTION SCHEDULE - FALL 1984

Week	Task	Eval Form #	Completed By	Location
9/10	prelab 1 critique	3	student	schools
9/10	prelab 2 critique	3	student	schools
9/17	prelab 3 critique	3	student	schools
9/17	prelab 4 critique	3	student	schools
9/24	background survey	1	student	LBCC
9/24	pre-test	2	student	LBCC
9/24	Q-4 grade	5	instructor	schools
10/1	lab 1 critique	3	student	LBCC
10/1	T-1 grade	5	instructor	schools
10/8	lab 2 critique	3	student	LBCC
10/15	lab 1 grade	5	instructor	LBCC
10/15	lab 2 grade	5	instructor	LBCC
10/15	lab 3 critique	3	student	LBCC
10/15	Q-5 grade	5	instructor	schools
10/29	lab 4 critique	3	student	LBCC
10/29	Q-6 & Q-7 grades	5	instructor	schools
11/5	lab 3 grade	5	instructor	LBCC
11/5	lab 4 grade	5	instructor	LBCC
11/5	T-2 grade	5	instructor	schools
11/12	lab 5 critique	3	student	LBCC
11/19	Q-8 & Q-9 grades	5	instructor	schools

CONTINUED ON OTHER SIDE

9/4/84

Week	Task	Eval Form #	Completed By	Location
11/26	lab 6 critique	3	student	LBCC
12/3	lab 5 grade	5	instructor	LBCC
12/3	lab 6 grade	5	instructor	LBCC
12/3	T-3 score	5	instructor	schools
12/3	cost & schedule survey	4	student	LBCC
12/3	final critique	7	student	LBCC
12/10	final grade	5	instructor	LBCC
every month	default record	6	instructor	both
as completed	supplemental materials	cmpltd manual	student	schools

For information, additional copies of forms, and pick-up of completed forms, call:

David Lin (754-2961)
Sam Stern (754-2733)
Warren Suzuki (754-2961)

New REA Project

DATA COLLECTION SCHEDULE - FALL 1984
(Abbreviated for High Schools)

Week	Task	Eval Form #	Completed By	Location
9/10	prelab 1 critique	3	student	schools
9/10	prelab 2 critique	3	student	schools
9/17	prelab 3 critique	3	student	schools
9/17	prelab 4 critique	3	student	schools
9/24	Q-4 grade	5	instructor	schools
10/1	T-1 grade	5	instructor	schools
10/15	Q-5 grade	5	instructor	schools
10/29	Q-6 & Q-7 grades	5	instructor	schools
11/5	T-2 grade	5	instructor	schools
11/19	Q-8 & Q-9 grades	5	instructor	schools
12/3	T-3 score	5	instructor	schools
every month	default record	6	instructor	both
as completed	supplemental materials	cmpltd manual	student	schools

9/4/84

New REA Project

DATA COLLECTION SCHEDULE - FALL 1984
(Abbreviated for LBCC)

Week	Task	Eval Form #	Completed By	Location
9/24	background survey	1	student	LBCC
9/24	pre-test	2	student	LBCC
10/1	lab 1 critique	3	student	LBCC
10/8	lab 2 critique	3	student	LBCC
10/15	lab 1 grade	5	instructor	LBCC
10/15	lab 2 grade	5	instructor	LBCC
10/15	lab 3 critique	3	student	LBCC
10/29	lab 4 critique	3	student	LBCC
11/5	lab 3 grade	5	instructor	LBCC
11/5	lab 4 grade	5	instructor	LBCC
11/12	lab 5 critique	3	student	LBCC
11/26	lab 6 critique	3	student	LBCC
12/3	lab 5 grade	5	instructor	LBCC
12/3	lab 6 grade	5	instructor	LBCC
12/3	cost & schedule survey	4	student	LBCC
12/3	final critique	7	student	LBCC
12/10	final grade	5	instructor	LBCC
every month	default record	6	instructor	both

9/4/84

RURAL ELECTRONICS ACCORD PROJECT
Department of Vocational and Technical Education Oregon State University

DATE: January 2, 1985

TO: Participating Instructors

FROM: David Lin (754-2961)
Sam Stern (754-2733)
Warren Suzuki (754-2961)

RE: Data Collection Schedule and Instruments and Instructional Materials.

Enclosed are copies of the supplemental instructional materials for the Rural Electronics Accord Project. They are:

Glossary;
Fractions;
Scientific Notations;
Equations;
Two-variable Equations.

High school teachers should give one copy of each unit to students when they start their participation in the Rural Electronics Accord Project for the first time. Students should be encouraged to write their comments and concerns in the materials and to turn them in to you. You are also encouraged to review the supplemental materials when time permits. We are particularly concerned with their accuracy, completeness and readability. It should be noted, however, that these materials supplement the textbooks, laboratory manual and dictionary which have been provided to the students by the project. As an example, the materials on solving for one and two unknowns were not meant to substitute for successful completion of an algebra course.

Also enclosed are forms with which we are collecting information that we will need for three purposes. The first purpose is to provide feedback for improving the electronics instruction provided during the Rural Electronics Accord Project. The second purpose is to inform our funding agency, the Oregon Department of Education, of our progress with the project. The third purpose is to help other schools and colleges in Oregon and nationally implement the Rural Electronic Accord Project's methods and materials. The data collection forms, when they should be completed, and by whom they should be completed are described in the attached schedule.

Please feel call us if you need additional materials or forms or if you have any questions. We will probably visit you during the first week of each month to pick up forms that have been completed.

cc: Wayne Johnson
Pete Scott

New REA Project

DATA COLLECTION SCHEDULE

Type of Information	Form No.	Form Name	Completed by	Location
Background information (administer during first week)	1	Background Survey	New students	High schools
Indication of ability in math, science and reading (administer during first week)	2	Pre-measurement	New students	High schools
Quiz and test grades	5	Student Score Record	High school instructors	High schools
Student opinions on the materials and methods (administer after completion of each lab activity)	3	Unit Critique	Students	LBCC/Lebanon
Lab grades	5	Student Score Record	Laboratory instructors	LBCC/Lebanon
Final term grades	5	Student Score Record	Laboratory	LBCC/Lebanon
Problems, mistakes, and suggestions	6	Default Record	Instructors	High schools/ LBCC

1/2/85

LINN-BENTON
EDUCATION SERVICE DISTRICT
905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

New REA Project Form 1

BACKGROUND SURVEY

Your answers on this survey will help us to determine how much experience and preparation you have in electronics and related subjects. We will use this information to improve the materials that you will use.

What is your LBCC identification (ID) number? _____

Please answer as many of the questions as you can. Circle the letter which best answers each question. The information that you provide will be kept in strictest confidence.

1. What is your sex?

   a. Female.
   b. Male.

2. How old are you?

   a. Less than 14 years.
   b. 14 years old.
   c. 15 years old.
   d. 16 years old.
   e. 17 years old.
   f. 18 years old.
   g. 19 years old.
   h. Older than 19 years.

3. What grade are you in now?

   a. 9th grade.
   b. 10th grade.
   c. 11th grade.
   d. 12th grade.
   e. Others (Please specifiy). _____

4. Have you completed or are you now enrolled in any of the following courses?

   4.1 Algebra.

      a. Completed.
      b. Taking now.
      c. Never.

CONTINUE ON THE OTHER SIDE

4.2 Geometry.

a. Completed.
b. Taking now.
c. Never.

4.3 Trigonomety.

a. Completed.
b. Taking now.
c. Never.

4.4 Physics.

a. Completed.
b. Taking now.
c. Never.

4.5 Chemistry.

a. Completed.
b. Taking now.
c. Never.

4.6 Electronics (other than this class).

a. Completed.
b. Taking now.
c. Never.

5. Have you ever worked on an electronics project or use electronics testing equipment (i.e., VOM, Oscilloscope)?

a. No.
b. 1 or 2 times.
c. Several times.
d. Very often.

6. Have you ever used computers, including microcomputers?

a. Never.
b. Only a few times.
c. Many times, but still do not feel comfortable with them.
d. Many times and feel very comfortable with them.

7. Have you written computer programs?

a. No.
b. Yes, one or two.
c. Yes, a few.
d. Yes, a lot of them.

THANK YOU FOR YOUR HELP!

LINN-BENTON
EDUCATION SERVICE DISTRICT
905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

New REA Project Form 2

PRE-MEASUREMENT

Instruction

This is not a test. It is a measurement. The purpose of this measurement is to know your current background in reading, math and science. We will use what we know about you to improve our instruction. The result of this measurement will not affect your final grade in this class.

Please answer as many questions as you can; do not guess.

What is your LBCC identification number? _____

Part I

A. What do each of the following words mean? Circle the letter that best describes each term.

1. oscillate

   a. close
   b. facilitate
   c. formulate
   d. vibrate

2. indicate

   a. hide
   b. save
   c. sense
   d. show

3. characteristic

   a. competitive
   b. honest
   c. representative
   d. honest

4. source

   a. agreement
   b. liaison
   c. origin
   d. witchcraft

5. equivalent

   a. effective
   b. matching
   c. simplified
   d. surplus

6. amplify

   a. increase
   b. fluctuate
   c. true
   d. rotate

7. constant

   a. accurate
   b. polite
   c. required
   d. uniform

8. impede

   a. deny
   b. enhance
   c. insult
   d. obstruct

9. inverse

   a. obstinate
   b. opposite
   c. reciprocal
   d. reverse

10. component

   a. element
   b. risk
   c. symbol
   d. warrior

B. Some of the words below are correctly spelled and some are not. For each word, write the word correctly on the line at the right of it. Do so even though the word is <u>correctly</u> spelled.

11. discription _____

12. efficency _____

13. seperate _____

14. nineth _____

15. parallel _____

16. referrence _____

17. tollerance _____

18. experiance _____

19. insulator _____

20. permenent _____

Part II

Write your answers on the blanks provided for the problems. Do not use a calculator to solve the problems.

1. 1469 + 598 = _____

2. 2310 - 2345 = _____

3. $53.10 X 2.5 _____

4. Find the average of
   47, 73, 13, 31, 26 _____

5. 4 X 8 - 9 - 2 X 7 = _____

6. -64 - (-6) - (-4) =
   (note: all numbers are negative.) _____

7. Change the following two fractions into their decimal form:

   a. 3/5 _____

   b. 25/8 _____

8. 4/3 X 1/8 = _____

9. 2/9 divide by 1/9 = _____

10. 4.3 - 0.987 = _____

11. 5XY - (4XY - XY) = _____

12. 3A + (A - 4) - (3A +1) = _____

13. If X = 2 and Y = 3 then
    3X + 2X^{Y} + 2(Y - X) = _____

14. 2X + Y = 4
    2X + 2Y =6 Y = ? _____

15. $(2^3)^2$ = _____

16. 5^{-2} = _____

17. The average of 3 numbers is 14. Two of the numbers are 15 and 21. What is the third number?

_____

18. If 15 feet of antenna wire weighs 15/16 pound, how much does one foot of antenna wire weigh?

_____

19. Four electric motor develop horsepower rating of 3/4 hp, 1/3 hp, 1/2 hp, 1/4 hp. What is the total horsepower developed by the four motors?

_____

20. What is the number represented by 5.2×10^3? _____

21. What is the number represented by 5.2×10^{-3}? _____

22. The 6.2×10^{14} divided by 3.1×10^6 _____

23. What are the following numbers?

a. 3K _____

b. 2M _____

c. 1m _____

Part III

Circle the letter that best answer each question.

1. Which of the following elements has the best conductance?

   a. copper
   b. iron
   c. lead
   d. silicon

2. Which of the following elements has the least conductance?

   a. carbon
   b. gold
   c. nickel
   d. zinc

3. Which of the following atoms weighs the least?

   a. chlorine
   b. helium
   c. nitrogen
   d. oxygen

4. Which of the following materials has the smallest volume?

   a. atom
   b. electron
   c. neutron
   d. proton

5. Which of the following materials has a negative charge?

   a. core of nuclera
   b. electron
   c. neutron
   d. proton

6. Which of the following units is used for measuring force?

   a. joule
   b. newton
   c. maxwell
   d. volt

7. If you mixed oxygen and hydrogen in a 1:2 ratio, what kind of material may be produced?

   a. chlorine gas
   b. hydrogen peroxide
   c. hydrogen
   d. water

8. If you can jump 6 feet on the earth, how far can you jump on the moon? (* the gravity constant of moon is 1/6 of earth.)

   a. 1 foot
   b. 6 feet
   c. 18 feet
   d. 36 feet

9. What are both X-ray and radio waves?

   a. cosmic rays
   b. electricity
   c. electromagnetic radiation
   d. heat radiation

10. What is the basic unit of current?

   a. ampere
   b. ohm
   c. volt
   d. watt

LINN-BENTON
EDUCATION SERVICE DISTRICT
905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

New REA Project Form 3

UNIT CRITIQUE

You have just completed a unit. We would like to know how well the instruction helped you. All information that you provide will be kept confidential and will not affect your grade in this class.

What is your LBCC ID number? _____

1. Which lab activity have you just completed? Activity # _____

2. How many class periods did you work on the topics relating to this activity (include teacher's instruction, self-instruction, watching a video-tape, experience)?

   _____ days

   Please list all of the dates that you worked on this activity.

   _____

3. How many minutes did you spend on your reading assignment out of class for this activity?

   _____ minutes.

4. How many minutes did you spend on your other homework (exercises, problems) relating to this activity?

   _____ minutes.

5. How difficult or easy was your text book on the topics concerning this activity? (Circle the letter that best describes your answer)

   a. too easy.
   b. very easy.
   c. easy.
   d. difficult in parts.
   e. difficult.
   f. very difficult.

CONTINUE ON THE OTHER SIDE

6. How difficult or easy was the lab manual for this activity? (Circle one letter only)

   a. no lab manual for this lab activity.
   b. too easy.
   c. very easy.
   d. easy.
   e. difficult in parts.
   f. difficult.
   g. very difficult.

7. How was the quality of the pictures on the video-tape for the topics concerning this activity?

   a. no video-tape for this lab activity.
   b. excellent.
   c. most of them were excellent.
   d. most of them were good.
   e. a lot of them were fair.
   f. a lot of them were poor.

8. How was the quality of the sound on the video-tape for the topics relating to this activity?

   a. no video-tape for this lab activity.
   b. easy to understand.
   c. somewhat easy to understand.
   d. difficult to understand in parts.
   e. difficult to understand.
   f. very difficult to understand.

9. Did you need to wait for any equipment that you needed to complete this activity?

   a. no.
   b. yes, but less than 5 minutes.
   c. yes, but less than 10 minutes.
   d. yes, and more than 10 minutes.

   If your answer is 'yes', please list the names of the equipment.

   _____

10. In general, how well did this unit help you to learn electronics?

    a. excellent.
    b. good.
    c. fair.
    d. poor.
    e. awful.

LINN-BENTON
EDUCATION SERVICE DISTRICT
905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

New REA Project Form 3A

UNIT CRITIQUE

You have just completed a unit using CAVI (Computer Assisted Video Instruction). We would like to know how well the instruction helped you. All information that you provide will be kept confidential and will not affect your grade in this class.

What is your LBCC ID number? _____

What is your name? _____

1. Which posttest did you just complete? Posttest # _____

2. How many times have you taken this posttest? _____ times.

3 What is today's date? _____

4. How difficult or easy to understand was the reading material for this unit? (Circle one letter only)

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. somewhat difficult.
   e. difficult.
   f. very difficult.

5. How difficult or easy to understand was the theory tape ?

   a. very easy to understand.
   b. easy to understand.
   c. somehwhat easy to understand.
   d. somewhat difficult to understand.
   e. difficult to understand.
   f. very difficult to understand.

CONTINUE ON THE OTHER SIDE

6. How much did the lab job to help you to clarify theories or ideas presented in the Heath text book?

   a. very helpful.
   b. helpful.
   c. somewhat helpful.
   d. little helpful.
   e. very little helpful.

7. How clearly did the lab job or skill module show you how to use the electric devices in this unit?

   a. very clear.
   b. clear.
   c. fair.
   d. poor.
   e. awful.

8. How clear were the pictures shown through the video-tape?

   a. very clear.
   b. clear.
   c. fair.
   d. poor.
   e. awful.

9. Did you have to wait for any equipment that you needed to complete this unit?

   a. no.
   b. yes, but less than 5 minutes.
   c. yes, but less than 10 minutes.
   d. yes, and more than 10 minutes.

   If your answer is 'yes', please list the names of the equipment.

   _____

10. In general, how well did this unit help you to learn electronics?

    a. excellent.
    b. good.
    c. fair.
    d. poor.
    e. awful.

LINN-BENTON
EDUCATION SERVICE DISTRICT
905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

New REA Project Form 3B

UNIT CRITIQUE

We need to know your opinion on the Bell text book to improve our instruction. Please answer all questions followed. The information that you provided will be kept confidential and will not affect your grade in this class.

What is your LBCC number? _____

What is your name? _____

1. What is today's date? _____

2. How well did the Bell text book help you to clarify the theories or ideas which you learned in the class?

   a. very helpful.
   b. helpful.
   c. somewhat helpful.
   d. little help.
   e. very lillte help.
   f. I don't know.

3. How easy or difficult was the text book to understand?

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. somewhat difficult.
   e. difficult.
   f. very difficult.

4. How easy or difficult was the homework that your instructor assigned to you?

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. somewhat difficult.
   e. difficult.
   f. very difficult.

CONTINUE ON THE OTHER SIDE

5. Did you read all sections in your text book that your instructor assigned to you?

   a. all of them.
   b. most of them.
   c. part of them which you thought might be important.
   d. some sections of the front pages.
   e. few of them.

6. On average, how many hours did you work on the Bell book every week (including homework)?

   a. less than 2 hours.
   b. 3 - 5 hours.
   c. 5 - 7 hours.
   d. 7 - 9 hours.
   e. 9 - 11 hours.
   f. 11 - 13 hours.
   g. more than 13 hours.

7. On average, how many hours did you spend on reading the Bell book every week (not including homework)?

   a. less than 1 hour.
   b. 1 - 2 hours.
   c. 2 - 3 hours.
   d. 3 - 4 hours.
   e. 4 - 5 hours.
   f. 5 - 6 hours.
   g. 6 - 7 hours.
   h. more than 7 hours.

8. By now, from which source did you learn the most about electric theories or ideas in this course? (choose one only)

   a. Heath text book.
   b. theory tape.
   c. active homework.
   d. Bell text book and homework problems.
   e. instructor.
   f. other (please indicate: _____)

New REA Project Form 5

STUDENT SCORES RECORD

School/College: _____

Instructor: _____

Period (inclusive dates): _____

LBCC ID NO.	Quiz/Test/Lab	Grade/Score	Date Completed

(Please provide raw scores.)

Return to: David Lin (754-2961)

1/2/85

New REA Project Form 6

DEFAULT RECORD

Recorder: _____ School/College: _____ Date: _____

If you find any mistakes or defaults in the text book, lab manual, video-tape, computer program or any instructional material, please record them below. You may also use this sheet to record your suggestions.

Source	Section or Page	Default	Improvement

Suggestions:

LINN-BENTON
EDUCATION SERVICE DISTRICT
905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

New REA Project Form 7 (Fall 1984)

FINAL TERM CRITIQUE

You should be completing this term's participation in the Rural Electronics Accord Project. We would like to know how well this term's instruction has helped you learn about electricity and electronics. Information that you provide will be kept confidential and will not affect your grade in this class.

What is your LBCC ID number? _____

1. Overall, how difficult or easy to learn were the electric theories or ideas this term? (Circle one letter only)

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. difficult.
   e. very difficult.

2. Which were the most difficult theories or ideas for you to understand this term?

   a. resistance and conductance.
   b. voltage concepts.
   c. current concepts.
   d. Ohm's Law and Watt's Law.
   e. series-parallel circuits.
   f. voltage and current dividers.

3. Which were the easiest theories or ideas for you to learn this term?

   a. resistance & conductance.
   b. voltage concept.
   c. current concept.
   d. Ohm's Law & Watt's Law.
   e. series-parallel circuits.
   f. voltage & current dividers.

4. Overall, how fast or slow was the instruction during this term?

   a. very fast.
   b. fast.
   c. somewhat fast.
   d. appropriate.
   e. somewhat slow.
   f. slow.
   g. very slow.

Continue On Next Page

5. Overall, from which source did you learn the most about electric theories or ideas during this term?

a. Bell textbook.
b. homework problems.
c. lab activities.
d. instructor.
e. viedo-tapes.
f. other. (Please indicate: _____)

6. Overall, how well did the textbook help you to understand the theories or ideas which you learned in this class?

a. very helpful.
b. helpful.
c. somewhat helpful.
d. little help.
e. very little help.
f. I don't know.

7. Overall, how well did the homework problems help you to understand the theories or ideas which you learned this term?

a. very helpful.
b. helpful.
c. somewhat helpful.
d. little help.
e. very little help.
f. I don't know.

8. Overall, how well did the lab activities help you to understand the theories or ideas which you learned this term?

a. very helpful.
b. helpful.
c. somewhat helpful.
d. little help.
e very little help.
f. I don't know.

9. Overall, how well did the viedo-tapes help you to understand theories or ideas which you learned this term?

a. very helpful.
b. helpful.
c. somewhat helpful.
d. little help.
e. very little help.
f. I don't know.

Continue On Next Page

10. In this program, lab activities were held during the evenings. Was this okay?

a. great.
b. okay most of the time.
c. okay some of the time.
d. I didn't like it.
e. terrible.

11. How long did it take you to get to the LBCC campus or Benton Center for a lab?

_____(minutes)

12. How did you normally get to the LBCC campus or Benton Center? (Circle one only)

1. walked.
2. rode a bike.
3. drove a motorcycle or moped or automobile.
4. was driven by someone else.
5. other types of transportation (please specify: _____

13. How much did it cost you for textbooks, lab manuals or other reference books for this program during this term?

_____(dollars)

14. If the evening schedule was inconvenient for you, what other times would be better for you.

_____

15. How important to you was the opportunity to earn Linn-Benton Community College credit while participating in this program?

1. very important.
2. important.
3. neither important nor unimportant.
4. unimportant.
5. very unimportant.

16. Would you encourage friends or classmates to enroll in this program next term if they asked you about it?

1. yes, very much so.
2. yes.
3. yes, but with some hesitation.
4. maybe.
5. no.

Continue On Next Page

17. How could we interest your classmates in enrolling in this program?

18. Is there any specific way we could improve this program for you?

THANKS FOR YOU HELP! Please fold this in half and give it to your instructor.

LINN-BENTON
EDUCATION SERVICE DISTRICT
905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

New REA Project Form 8

INSTRUCTOR CRITIQUE

We have been collecting considerable evaluative information from and on students during the year. We also need to know how well the Rural Electronics Accord Project is functioning from your perspective. Please complete this questionnaire and return it to us in the attached envelope.

Circle the letter that best represents your answer for each question. When asked for written comments, please be as specific as possible.

1. Which of the following responsibilities did you have in the project:

   a. Electronics theory instructor.
   b. Laboratory instructor.
   c. Both theory and lab instructor.

2. Looking back to when you were first introduced to the New Rural Electronics Accord Project, did you understand the goals for the project and what you were getting involved with?

   a. yes, very much so.
   b. yes.
   c. yes, somewhat
   d. marginally.
   e. no.

3. Considering the workshops, briefings and/or printed materials, was the information on what was expected of you sufficient for you to function effectively?

   a. excellent.
   b. good.
   c. adequate.
   d. marginal.
   e. inadequate.

4. How difficult or easy was it to use the instructional schedules?

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. marginal.
   e. somewhat difficult.
   f. difficult.
   g. very difficult.

5. How difficult or easy was it for you to implement and manage the instruction (including materials) in the New REA Project?

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. marginal.
   e. somewhat difficult.
   f. difficult.
   g. very difficult.

6. Did you have to "motivate" the students who participated in the New REA Project to complete the instructional materials for which you were responsible?

   a. yes, very much so.
   b. yes, somewhat.
   c. yes, occassionally.
   d. yes, but very infrequently.
   e. no.

7. Did you experience any difficulty with any of instructional materials that were developed specifically for the New REA Project (including technical accuracy, editing, and readability)?

   a. yes, considerable.
   b. yes, somewhat.
   c. yes, occassionally.
   d. yes, but very infrequently.
   e. no.

8. Were textbooks, materials and equipment delivered to you when you needed them?

   a. yes, all of the time.
   b. yes, most of the time.
   c. yes, some of the time.
   d. yes, occassionally.
   e. no.

9. What was the quality of the materials, including textbooks?

   a. excellent.
   b. good.
   c. adequate.
   d. marginal.
   e. inadequate.

10. What was the quality of the equipment?

   a. excellent.
   b. good.
   c. adequate.
   d. marginal.
   e. inadequate.

11. How responsive (flexible, supplemental activities, alternative goals, etc.) was the program (materials, equipment, schedule, etc.) to the bright student?

   a. very responsive.
   b. responsive.
   c. somewhat responsive.
   d. somewhat unresponsive.
   e. unresponsive.
   f. very unresponsive.

12. How responsive was the program to the lower ability student?

   a. very responsive.
   b. responsive.
   c. somewhat responsive.
   d. somewhat unresponsive.
   e. unresponsive.
   f. very unresponsive.

13. Do you believe that your administrators supported (and not only by what they said to you) the New Rural Electronics Accord Project?

   a. yes, very much so.
   b. yes.
   c. yes, somewhat.
   d. no.

14. Overall, how well did the New Rural Electronics Accord Project prepare students in electronics?

   a. excellent.
   b. good, a few refinements needed.
   c. fair, some modifications needed.
   d. marginal, many modifications needed.
   e. poor.

15. Would you be willing to participate again in the first year of electronics instruction (DC theory) if it were offered next year (assuming appropriate modifications were made)?

    a. strongly agree.
    b. agree.
    c. somewhat agree.
    d. neither agree to disagree.
    e. somewhat disagree.
    f. disagree.
    g. strongly disagree.

16. Would you be willing to participate in a second year of electronics instruction (AC theory) if it were available?

    a. strongly agree.
    b. agree.
    c. somewhat agree.
    d. neither agree nor disagree.
    e. somewhat disagree.
    f. disagree.
    g. strongly disagree.

17. Based on your experience with this project, are you more willing and able to advise your students on LBCC and its programs? (for high school instructors, only.)

    a. I was doing it before the project and will continue to do so.
    b. much more willing now.
    c. somewhat willing.
    d. no.

18. Your comments are welcomed.

Thank you for your help. Please place this questionnaire in the enclosed envelope and drop it in the mail.

LINN-BENTON
EDUCATION SERVICE DISTRICT
905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

New REA Project Form 9

ADMINISTRATOR CRITIQUE

We have been collecting considerable evaluative information from and on students during the year. We also need to know how well the Rural Electronics Accord Project is functioning from your perspective. Please complete this questionnaire and return it to us in the attached envelope.

Circle the letter that best represents your answer for each question. When asked for written comments, please be as specific as possible.

1. Looking back to when you were first introduced to the New Rural Electronics Accord Project, did you understand the goals for the project and what you were getting involved with?

   a. yes, very much so.
   b. yes.
   c. yes, somewhat
   d. marginally.
   e. no.

2. Considering the workshops, briefings and/or printed materials, was the information on what was expected of you sufficient for you to function effectively?

   a. excellent.
   b. good.
   c. adequate.
   d. marginal.
   e. inadequate.

3. How difficult or easy was it for you to implement and manage the instruction (including materials) in the New REA Project?

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. marginal.
   e. somewhat difficult.
   f. difficult.
   g. very difficult.

4. Did you have to "motivate" your instructor who participated in the New REA Project?

   a. yes, very much so.
   b. yes, somewhat.
   c. yes, occassionally.
   d. yes, but very infrequently.
   e. no.

5. Were textbooks, materials and equipment delivered to your school when they were needed?

   a. yes, all of the time.
   b. yes, most of the time.
   c. yes, some of the time.
   d. yes, occassionally.
   e. no.

6. What was the quality of the materials, including textbooks?

   a. excellent.
   b. good.
   c. adequate.
   d. marginal.
   e. inadequate.
   f. no opinion.

7. What was the quality of the equipment?

   a. excellent.
   b. good.
   c. adequate.
   d. marginal.
   e. inadequate.
   f. no opinion.

8. How responsive (flexible, supplemental activities, alternative goals, etc.) was the program (materials, equipment, schedule, etc.) to the <u>bright</u> student?

   a. very responsive.
   b. responsive.
   c. somewhat responsive.
   d. somewhat unresponsive.
   e. unresponsive.
   f. very unresponsive.
   g. no opinion.

9. How responsive was the program to the lower ability student?

   a. very responsive.
   b. responsive.
   c. somewhat responsive.
   d. somewhat unresponsive.
   e. unresponsive.
   f. very unresponsive.
   g. no opinion.

10. Overall, how well did the New Rural Electronics Accord Project prepare students in electronics?

   a. excellent.
   b. good, a few refinements needed.
   c. fair, some modifications needed.
   d. marginal, many modifications needed.
   e. poor.
   f. no opinion.

11. Would you be willing to participate again in the first year of electronics instruction (DC theory) if it were offered next year (assuming appropriate modifications were made)?

   a. strongly agree.
   b. agree.
   c. somewhat agree.
   d. neither agree to disagree.
   e. somewhat disagree.
   f. disagree.
   g. strongly disagree.

12. Would you be willing to participate in a second year of electronics instruction (AC theory) if it were available?

   a. strongly agree.
   b. agree.
   c. somewhat agree.
   d. neither agree nor disagree.
   e. somewhat disagree.
   f. disagree.
   g. strongly disagree.

13. Overall, did the project adequately articulate high school and community college instruction?

   a. strongly agree.
   b. agree.
   c. somewhat agree.
   d. neither agree nor disagree.
   e. somewhat disagree.
   f. disagree.
   g. strongly disagree.

14. Please rate the quality of the guidance information provided by the project to interest students in participating in the New REA Project.

a. excellent.
b. good.
c. adequate.
d. marginal.
e. inadequate.

15. If your district needed to purchase replacement books, materials and supplies, would you be willing to recommend to your administrators that your high school(s) should continue its/their participation in the New REA Project?

a. yes, even if it meant reallocation of vocational resources.
b. yes, only if funds were provided.
c. maybe.
d. no.

16. Would you like to participate in similar efforts for other vocational areas (e.g., mechanics, agriculture, business)?

a. very much so.
b. yes.
c. maybe.
d. no.

17. Would your district participate in similar efforts in academic areas?

a. very much so.
b. yes.
c. maybe.
d. no.

Please suggest areas: _____
_____
_____

18. Your comments are welcomed.

Thank you for your help. Please place this questionnaire in the enclosed envelope and drop it in the mail.

LINN-BENTON EDUCATION SERVICE DISTRICT

905 4th Ave. S E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

New RFA Project Form 7A (Fall 1984)

FINAL TERM CRITIQUE

You should be completing this term's participation in the Rural Electronics Accord Project. We would like to know how well this term's instruction has helped you learn about electricity and electronics. Information that you provide will be kept confidential and will not affect your grade in this class.

What is your LBCC ID number? _____

1. Overall, how difficult or easy to learn were the electric theories or ideas this term? (Circle one letter only)

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. difficult.
   e. very difficult.

2. Which were the most difficult theories or ideas for you to understand this term?

   a. resistance and conductance.
   b. voltage concepts.
   c. current concepts.
   d. Ohm's Law and Watt's Law.
   e. series-parallel circuits.
   f. voltage and current dividers.

3. Which were the easiest theories or ideas for you to learn this term?

   a. resistance & conductance.
   b. voltage concept.
   c. current concept.
   d. Ohm's Law & Watt's Law.
   e. series-parallel circuits.
   f. voltage & current dividers.

4. Overall, how fast or slow was the instruction during this term?

   a. very fast.
   b. fast.
   c. somewhat fast.
   d. appropriate.
   e. somewhat slow.
   f. slow.
   g. very slow.

Continue On Next Page

5. Overall, from which source did you learn the most about electric theories or ideas during this term?

a. Bell texthook.
b. homework problems.
c. lab activities.
d. instructor.
e. viedo-tapes.
f. other. (Please indicate: _____)

6. Overall, how well did the Heath text book help you to understand the theories or ideas which you learned in this class?

a. very helpful.
b. helpful.
c. somewhat helpful.
d. little help.
e. very little help.
f. I don't know.

7. Overall, how well did the Bell text book and homework problems help you to understand the theories or ideas which you learned this term?

a. very helpful.
b. helpful.
c. somewhat helpful.
d. little help.
e. very little help.
f. I don't know.

8. Overall, how well did the active homework help you to understand the theories or ideas which you learned this term?

a. very helpful.
b. helpful.
c. somewhat helpful.
d. little help.
e very little help.
f. I don't know.

9. Overall, how well did the theory tapes, skill modules and lab jobs help you to understand theories or ideas which you learned this term?

a. very helpful.
b. helpful.
c. somewhat helpful.
d. little help.
e. very little help.
f. I don't know.

Continue On Next Page

10. In this program, lab activities were held during the evenings. Was this okay?

a. great.
b. okay most of the time.
c. okay some of the time.
d. I didn't like it.
e. terrible.

11. How long did it take you to get to the school for an evening lab?

_____(minutes)

12. How did you normally get to the school for an evening lab? (Circle one only)

1. walked.
2. rode a bike.
3. drove a motorcycle or moped or automobile.
4. was driven by someone else.
5. other types of transportation (please specify: _____

13. How much did it cost you for textbooks, lab manuals or other reference books for this program during this term?

_____(dollars)

14. If the evening schedule was inconvenient for you, what other times would be better for you.

_____

15. How important to you was the opportunity to earn Linn-Benton Community College credit while participating in this program?

1. very important.
2. important.
3. neither important nor unimportant.
4. unimportant.
5. very unimportant.

16. Would you encourage friends or classmates to enroll in this program next term if they asked you about it?

1. yes, very much so.
2. yes.
3. yes, but with some hesitation.
4. maybe.
5. no.

Continue On Next Page

17. How could we interest your classmates in enrolling in this program?

18. Is there any specific way we could improve this program for you?

THANKS FOR YOU HELP! Please fold this in half and give it to your instructor.

LINN-BENTON
EDUCATION SERVICE DISTRICT

905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

May 15, 1985

Dear Colleague:

We are approaching the end of the New Rural Electronics Project. We are starting to orepare the final report for the Oregon Department of Education. We now need some critical information from you to complete an overall view of the project.

Will you complete the enclosed questionnaire and return it in the envelope we have provided? We encourage you to do this as soon as possible so that your views can be included in the report. As you can see, we have no way of identifying you which will enable us to keep your individual views confidential.

Please feel free to call me (754-2961) if you have any questions or concerns.

Sincerely,

Warren N. Suzuki
Oregon State University

LINN-BENTON
EDUCATION SERVICE DISTRICT
905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

LBCC ID No. _____

New REA Project Form 10

STUDENT END OF YEAR CRITIQUE

Up to now, you have given us a lot of information on what you have been learning in electronics. Your information has been very important to improving the program. We would now like your overall feelings about your electronics instruction. Please answer all the following questions. Circle the one letter that best describes your answer for each questions. Again, we want to remind you that all information you provide will be kept confidential and will not affect your grade in this class.

1. How many terms have you compeleted in the program?

   a. three (fall, winter, spring).
   b. two (winter and spring).
   c. one (spring only).

2. Overall, how difficult or easy to learn were the theories or ideas in this course? (Circle one letter only)

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. just right.
   e. somewhat difficult.
   f. difficult.
   g. very difficult.

3. Overall, how fast or slow was the instruction in this course?

   a. very fast.
   b. fast.
   c. somewhat fast.
   d. just right.
   e. somewhat slow.
   f. slow.
   g. very slow.

4. Overall, which one of the following was most helpful to you for learning about electricity theories or ideas?

   a. textbook.
   b. homework problems.
   c. lab activities.
   d. instructor.
   e. video-tapes.
   f. CAVI or computer assisted video instruction (Lebanon only).
   g. other. (Please indicate: _____)

5. Overall, which one of the following was the least helpful to you for learning about electricity theories or ideas in this course?

   a. textbook.
   b. homework problems.
   c. lab activities.
   d. instructor.
   e. video-tapes.
   f. CAVI or computer assisted video instruction (Lebanon only).
   g. none; they were all helpful

6. How easy or difficulty was it to understand the written materials (textbooks, handouts, lab manuals)?

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. just right.
   e. somewhat difficult.
   f. difficult.
   g. very difficult.

7. How easy or difficult was it to solve the mathematics problems?

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. just right.
   e. somewhat difficult.
   f. difficult.
   g. very difficult.

8. How easy or difficult was it to write the laboratory reports?

   a. very easy.
   b. easy.
   c. somewhat easy.
   d. just right.
   e. somewhat difficult.
   f. difficult.
   g. very difficult.

9. In this program, lab activities were held during the evenings. Was this okay?

   a. great.
   b. okay most of the time.
   c. okay some of the time.
   d. I didn't like it.
   e. terrible.

10. How much time did it take to get to the evening lab activity?

    _____ minutes one way.

11. How important was earning Linn-Benton Community College credit to you?

    a. very important.
    b. important.
    c. somewhat important.
    d. neither important nor unimportant.
    e. somewhat unimportant
    f. unimportant.
    g. very unimportant.

12. When you complete high school, what do you think you will be doing?

    a. enrolling in a 4-year university in electronics.
    b. enrolling in a 4-year university but in an area not related to electronics.
    c. enrolling in a community college in electronics.
    d. enrolling in a community college but in an area not related to electronics.
    e. working in electronics.
    f. working in an area not related to electronics.
    g. enlisting in a military service.
    h. unsure of what you will be doing.

13. Would you encourage friends or classmates to enroll in this program next year if they asked you about it?

    a. yes, very much so.
    b. yes.
    c. yes, but with some hesitation.
    d. maybe.
    e. no.

14. If we offered additional electronics instruction with the same schedule and instructional method in the future, would you enroll in it?

    a. yes, very much so.
    b. yes.
    c. yes, but with some hesitation.
    d. may be.
    e. no.

15. How could we interest your classmates in enrolling in this program? (Circle all that apply.)

a. provide better information on the program.
b. provide better information on job and educational options which could result from the program.
c. provide information on the program earlier.
d. change the school schedule so that more students can take advanced electronics.
e. change lab schedule for the program.
f. get students who influence other students to enroll in the program.
g. other (please provide your ideas):

16. Are there any specific ways we could have made this program more responsive and useful for you? _____

_____

_____

_____

_____

Thanks for your help! Please fold it in half and return it you your instructor.

We would also like to know how your parents/guardians feel about your taking part in the electronics program. Will you take the attached questionnaire and envelope home to them (you may look over the questionnaire)? Please encourage them to answer the questions then mail the questionnaire to us?

LINN-BENTON
EDUCATION SERVICE DISTRICT

905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

RURAL ELECTRONICS ACCORD PROJECT

May 15, 1985

Dear Parent or Guardian:

Your son/daughter has been participating in the Rural Electronics Accord Project. We are now determining how successful the project has been in helping your son/daughter learn about electronics.

You need not answer any or all questions, but we encourage you to do so. Your opinions are very important to us when we improve the program. Place your completed questionnaire in the self-addressed, stamped envelope and drop it in the mail. All information that you provide will be kept in strictest confidence; it will not affect your child's grade in any way.

Thank you for your help. Please feel free to call Wayne Johnson at the Linn-Benton Education Service District (967-8822), Pete Scott at Linn-Benton Community College (928-2361) or me at Oregon State University (754-2961) if you have any questions.

Sincerely yours,

Warren N. Suzuki
Oregon State University

The Rural Electronics Accord Project is a cooperative endeavor between Corvallis Schools, Greater Albany Schools, Lebanon Schools, Philomath Schools, Linn-Benton Education Service District, Linn-Benton Community College, and Oregon State University.

LINN-BENTON
EDUCATION SERVICE DISTRICT

905 4th Ave. S.E. : Albany, Oregon 97321-3199 : Phone (503) 967-8822

ID No. _____
(To keep your answers confidential)

New REA Project Form 11

PARENT SURVEY

Introduction: Please answer all of the following questions. Circle one letter only for each question.

1. How many terms did your son/daughter participate in the program?

   a. three (fall, winter, spring).
   b. two (winter and spring).
   c. one (spring only).
   d. I am not sure.

2. What is your overall impression of the program? (Circle one letter only)

   a. great, there ought to be more programs like this on.
   b. good, but some minor improvements are needed.
   c. fair, because minor improvements are needed.
   d. marginal, because major improvements are needed.
   e. poor, the program should not be offered again.

3. In this program, lab activities were held during the evenings. Was this okay?

   a. great.
   b. okay most of the time.
   c. okay some of the time.
   d. I didn't like it.
   e. terrible.

4. How important was your son/daughter's earning of Linn-Benton Community College credit to him/her?

   a. very important.
   b. important.
   c. somewhat important.
   d. neither important nor unimportant.
   e. somewhat unimportant
   f. unimportant.
   g. very unimportant.

5. Was the cost for your son/daughter to participate in the program acceptable to you?

   a. very expensive.
   b. expensive.
   c. somewhat expensive.
   d. about right.
   e. somewhat inexpensive.
   f. inexpensive.
   g. very inexpensive.

6. To what extent did you understand the purposes and how instruction would be offered when you were first informed about the electronics project?

   a. very clear understanding.
   b. clear understanding.
   c. somewhat clear understanding.
   d. somewhat unclear understanding.
   e. unclear understanding.
   f. very unclear understanding.

7. Would you encourage other parents/guardians to have their sons/daughters enroll in this program next year if they asked you about it?

   a. yes, very much so.
   b. yes.
   c. yes, but with some hesitation.
   d. maybe.
   e. no.

8. If we offered additional electronics instruction with the same schedule and instructional method for your son/daughter in the future, would you encourage him/her to participate in it?

   a. yes, very much so.
   b. yes.
   c. yes, but with some hesitation.
   d. may be.
   e. no.

9. How could we interest other parents/guardians in this program?

_____
_____
_____

You comments are welcomed!

_____
_____
_____
_____

Thanks for your help! Please fold it in half and return it in the pre-addressed, stamped envelope.

APPENDIX H

SUPPLEMENTAL CURRICULUM MATERIAL

(Project Developed)

FIELD TEST VERSION - 9/4/84

A Supplemental

GLOSSARY

for Electronics Education

Student: _____ School: _____

This glossary provides definitions of terms which you will use during the Rural Electronic Accord Project. We would like to know how well this glossary helped you. If you do not understand or are unsure of a definition, please let us know by writing your concern in this book. Your comment may be as simple as a question mark (?) next to a word or definition. Turn this glossary in to your teacher or instructor when you are done with it; it will be returned to you later. What you do in this glossary will <u>not</u> affect your grade for the course.

FOR FIELD TEST USE ONLY
Do not reproduce or use without
written consent of REA Project

THE RURAL ELECTRONICS ACCORD PROJECT

A Supplemental

GLOSSARY

for Electronics Education

by

Marie Egbert
Ralph Yoshimura
Chin-yen Lin
Sam Stern

Department of Vocational and Technical Education
Oregon State University

in cooperation with

Linn-Benton Education Service District
Linn-Benton Community College
Corvallis Schools, Greater Albany Schools, Lebanon Schools

September 1984

GLOSSARY

The purpose of this glossary is to define terms that are commonly used in electronics. Not all terms that you will use are included. Not all terms are completely defined or explained. Words are defined only well enough for you to get started in your reading of the textbooks and lab exercises. You may eventually need to use an electronics dictionary or the glossary in your text books to find the full meanings of terms and the meanings of all the terms you will use.

Some terms have more than one meaning. Which definition is needed will depend on how the term is used. As an example, a "semiconductor" could be a material (such as germanium, silicon, or arsenic) or an electronic device (such as a "chip" or transistor). If a term has more than one meaning, than each definition is numbered, as an example, (1). Not all possible meanings of terms are presented, only those which may be important to you during this program.

Many terms used in electronics are made up of two or more words. They also have many letters. Aids to help with recognizing the parts of terms are sometimes given. The aids are presented within "( )" right after the words. Spaces are used to divide terms into recognizable parts. As an example, "ferromagnetic" is also shown as "(ferro magnet ic)."

Often words sound differently than the way they look. Pronunciations of some of these terms are given to help you recognize them. The pronunciations are presented within "[ ]" right after the words. Spaces are used to divide terms into recognizable parts. As an example, "electrolyte" is shown as "[electro light]."

Active material - (1) Material in plates of storage battery, such as lead oxide. The material reacts chemically to produce electrical energy. (2) A material that is found on the screen of a cathode-ray tube. The material is a fluorescent (or shines when hit by electrons), such as calcium tungstate.

Admittance - (admit tance) How easily alternating current flows in a circuit. Admittance is the reciprocal of impedance and is usually expressed in mhos. The symbol for admittance is "Y" or "y."

Analog - (1) Something that is similar to something else. As an example, one formula can be compared to another because they are alike. For this meaning, this word can also be spelled "analogue." (2) In electrical measurement, analog means continuous measures or amounts. A volt-ohm meter that shows amounts or values with a pointer or arm on a face is an analog meter. When values are shown directly as numbers (e.g., LCD), then the meter gives digital readouts. (3) A computer that works with continuous values or amounts. Digital computers, on the other hand, work with clearly defined units. Most home computers or microcomputers are digital computers.

Atom - The smallest part of an element that has the characteristics of that element. As an example, the smallest part of hydrogen that looks like hydrogen is a hydrogen atom. The atom has a nucleus or core and electrons orbiting around the core. The hydrogen atom has one electron. Also see molecule.

Bonding - To very tightly join of two or more things. (1) To solder or weld or join together two devices so that current can flow from one to the other without being blocked. (2) To join two materials together well enough to shield the connection or prevent possible interference.

Branch - (1) In circuits, a path from a terminal or point common to one or more other paths. Like a tree, circuits can "branch out" from a common point. Each path or branch becomes a circuit in itself, although all paths may have a common ground. (2) In computer programming, two or more choices at a decision point.

Breakdown voltage - Electromotive force (voltage) at which an insulator can no longer hold back current. Sufficiently high potential difference could cause rapid current flow through an insulator, or insulator breakdown. Insulator breakdown could result in damage to the insulation. The most common dammage is melting and fire.

Capacitor - Device that stores electrical energy. Capacitors are usually made up of two conductor plates. The two plates are separated by a dielectric (insulating) material. Electrons are stored on one plate which creates a potential difference between the two plates.

Chassis ground - A metal structure on which components are attached. The structure serves as a common ground if it is also grounded.

Circuit - A complete path for electrical current to flow through. A circuit is usually a set of electrical conductors and devices with a start and an ending between which current flows. See "short circuit" and "open circuit."

Coercive force - Magnetic force which is applied to a magnetic material or magnetic field to reduce induction. The symbol for coercive force is "H."

Coil - Wire wrapped around a core. The core may be solid or hollow or air.

Conductance - (conduct ance) How easily a material will pass electricity. Conductance is the opposite of resistance (see Ohm's Law). The material may be a conductor or resistor. The symbol for conductance is "G."

Conductor - A material that will carry electrical current. The opposite of a conductor is a resistor. As an example, copper and gold are "good" conductors. Insulation is a very poor conductor of current.

Connector - Device that joins two parts. It also lets current flow from one part to the other part. As an example, one wire is soldered to one end of a connector. Another wire is soldered to the other end of the connector. Current should flow from one wire, through the connector, to the other wire.

Cut out - (1) An electrical device that stops current. Current can be interrupted either manually or automatically, depending on the type of device. (2) Two conductors that are exactly alike that are connected to another conductor (e.g., a cable).

Deflecting coil - Also known as a "deflective coil." Coil used in a cathode-ray tube to bend the electron beam. The coil produces a magnetic field that attracts or repels the electron beam.

Depolarize - (de polar ize) (1) To partially or totally remove an electrical charge from a material. (2) The process of restoring a battery or primary cell usually by adding something to the electrolyte.

Diamagnetic material - [dye a magnet ic] A substance, such as copper or silver, that tends to oppose magnetic lines of force. The opposition is very slight. Because they repel both poles of a magnet, diamagnetic materials tend to align themselves at a right angle to the field.

Dielectric - [dye electric] A material used between two plates of a capacitor. Dielectrics have an "insulating" effect that prevents current from moving between the two plates. However, current will "flow" from one plate to the other when the charge is greater than can be held back by the dielectric material.

Domain - In electronics, the part of a material in which all of the magnetic forces are going in one direction.

Eddy current - Alternating current applied to a coil will create voltage in a core that is an electrical conductor. The voltage will cause circulating currents or eddy currents to flow. Eddy currents cause the core to heat resulting in total core losses. Eddy current is also called "Foucault current."

Electrification - (1) A process that puts a positive or negative charge in a material. (2) Applying electricity to something. As an example, plugging a light fixture into an outlet is the electrification of it.

Electrolyte - [electro light] A solid or liquid chemical that reacts with other materials. An electrolyte breaks down into positive and negative ions. Electrolytes are used in primary cells and batteries as well as electroplating.

Electrolysis - [elec traw leh sis] A process of chemically changing a material by passing an electrical current through an electrolyte. Electroplating is an electrolytic process.

Electromagnetic induction - (electro magnet ic) Electrical potential induced (roughly, "created") in a coil as magnetic lines of force pass through it.

Electron - Part of an atom with a negative electrical charge. An atom has a nucleus (or core) and electrons. The electrons go around the nucleus. The number of electrons depends on the atomic weight of the element. Hydrogen has one electron and has an atomic weight of one.

Equivalent resistance - The use of one resistor to replace two or more resistors and still have the same resistance in the circuit. As an example, one 10 ohm resistor could replace two 5 ohm resistors that are placed in series.

Ferromagnetic material - (ferro magnet ic) A substance through which magnetic lines of force pass very easily. Ferromagnetic materials are used in making permanent magnets and electromagnets. Examples of ferromagnetic materials are iron, nickel, cobalt and ceramics known as "ferrites."

Flux density - Amount of magnetic flux (magnetic lines) that pass through a specific area of a material. The density is measured or at right angles to the lines.

Foucault current - See "eddy currents."

Galvanometer - [gal va nom eh ter] Instrument for measuring available electrical current. The galvanometer will also show in which direction the current is flowing. Both positive and negative values and a zero point are shown on the face. The galvanometer is sometimes referred to as a "null detector." Unlike a galvanometer, an ammeter displays only positive values arranged on one side of zero.

Ground - (1) A connection from a circuit to the earth. Usually the connection of a wire from a circuit to a pipe or rod that is stuck into the ground or buried underground. (2) A part of or point in a circuit connected to a positive terminal.

Hermetically sealed - Joining materials or covering joints so that gases cannot get to it; air tight.

Impedance - The total opposition a circuit offers to the flow of alternating current. It is measured in ohms and is the reciprocal of admittance. Symbol for impedance is "Z."

Impregnate - (1) To saturate or "soak" a material with a liquid or powder so that no air remains in the material. (2) To saturate the paper in a capacitor with a dielectric and thereby replace the air in the paper.

Incremental permeability - The ratio of the change in magnetic induction to the corresponding change in magnetizing force.

Induction - (1) Creating electrical potential in a conductor, such as a wire, by passing magnetic flux through it. (2) Creating a magnetic field in a material with electrical flux from another source, such as a magnet or a charged wire.

Infinity - A mathematical idea which means that there is no limit. The amount is so large that it is way beyond anything that we can imagine.

Insulation - A material that stops or halts electrical current from flowing. Glass and dry paper are insulators. They are very poor conductors of electricity.

Interface - (1) The point at which two things meet each other. As an example, there is an interface between a toaster plug and an outlet when the toaster is plugged in. (2) The parts of mating connectors that come into contact with each other. (3) The location in which two electronic circuits meet each other.

Internal resistance - A natural limitation on current flow in a primary cell or battery. The limitation can be caused by the size of the plates or terminals in a cell. Size and material of a plate or terminal and the type of electrolyte determines ability of the terminal to emit ions.

Kinetic energy - The energy or force that is in movement or motion. A rock that has been thrown has kinetic energy. The pain you feel when the rock hits you shows that the rock had a "moving" force or kinetic energy.

Kirchoff's Laws - [Kirk' hawf] Descriptions or "truths" about current and voltage in circuits. They were developed by Gustav Kirchoff. The laws and the rules obtained from them are most useful when analyzing complex circuits.

Lines of force - Imaginary lines that represent an electrical or magnetic field. Often called a "maxwell."

Logarithmic scale - A scale or "ruler" that uses logarithms for numbers. The distances between numbers on the scale become smaller as the numbers become larger. Numbers to the second power (X^2) will plot on a normal graph as a curved line. These same numbers will plot as a straight line when a logarithmic scale is used.

Magnetic field of strength - Magnetizing force. The amount of magnetomotive force in any given length in a magnetic circuit.

Magnetic flux - Magnetic "waves" or "lines." Magnetic forces spread out from a magnetized material like waves or lines. For a magnet, the lines are arcs from one pole to the other. Current flowing through a conductor, such as a wire, will also cause these magnetic "waves."

Magnetic shielding - A material used to protect a conductor, device or instrument from magnetic fields or flux. The material can be placed around a conductor, device, or instrument. The shield can also be placed between the source of magnetic flux and the device or instrument.

Make-before-break switch - See "shorting switch."

Mating connectors - Connectors for two conductors (e.g., wires) that are shaped in such a way that they can be easily joined. The shapes could also prevent incorrect joining of two connectors.

Maximum Power Transfer Theorem - A description of the relationsip between two networks that are connected. The maximum power will be absorbed by one network from another network at the two terminals where they are joined.

Molecule - The smallest part of a material that still is recognizable as that material. Molecules are made up of atoms. As an example, the water molecule consists of two atoms of hydrogen and one atom of oxygen. Adding or substracting any three of these atoms would result in another material.

Nodal point - A place in a wave system where there is a zero amplitude.

Node - A junction point, branch point or vertex. A point in a circuit from which paths branch out from of branch into.

Non-magnetic - A material that is not attracted by a magnet, cannot be magnetized and in which a potential cannot be induced. Examples of materials normally considered non-magnetic are wood, glass, rubber, and the plastics.

NPN transistor - Transistor with a p-type base and n-type collector and emitter.

N-type collector - Semiconductor material to which impurities have been added so that electrons serve as the majority of charge carriers.

Nucleus - (1) Center of a cell. (2) Center of an atom. The nucleus is the core of an atom. It has a positive charge.

Null detector - A galvanometer when used to detect a zero current condition in a circuit. The term "null" means zero.

Ohm's Law - A "truth" about the relationsip of electromotive force (E), current (I), and resistance (R). The relationship is $E = IR$.

Open circuit - An arrangement of conductors and devices that does not have a complete path through which current can flow. As an example, a "bad" joint between two wires would result in an open circuit if current could not move from one wire to the other.

Parallel circuit - A circuit in which one side of all the components or elements is connected together and the other side is connected together. A parallel cirucit has more than one path for the flow of electrical current.

Paramagnetic material - (para magnet ic) A substance, such as aluminum and platinum, that assists lines of magnetic force. Ferromagnetic materials are sometimes included in this group, but the term is usually applied to materials that only have a very slight magnetic effect.

Permanent magnetic moving coil - A device to generate electricity. It consists of a permanent magnet and a coil of wire. The coil of wire is passed through the magnetic flux (lines or forces) coming from the permanent magnet. As the coil cuts through the magnetic flux, electromotive force or voltage is induced in the wire of the coil.

Permeability - A measure of how susceptible a material is to magnetic flux.

PNP transistor - A transistor that is made from two p-type regions separated with an n-type region.

Polarize - (1) To cause a positive or negative charge to pile up. As an example, negative charges are stored on one plate of a capacitor and positive charges on the other plate. The piling up of electrons on a plate is polarization. As another example, electrons are attracted to one plate of a voltaic cell. This is also polarization. (2) To magnetize a material. The internal magnets of molecules are lined up with the magnetic lines of force. (3) To rearrange light rays or other types of radiation. (4) The shaping of connectors so that they can be joined in only one way. As an example, three-pronged electrical plugs can only be used with three-holed outlets or receptacles.

Potential difference - How much voltage exists between two points in a circuit. Sometimes referred to as "potential."

P-type base - Semiconductor material that has been chemically treated so that paths are made for electrons to be carriers.

Reciprocal - a specific type of inverse of a number. As an example, the reciprocal of 4 is 1/4; 1/16 is the reciprocal of 16. The number 4 is the same as 4 divided by 1 or 4/1. The inverse or opposite or reciprocal of 4/1 is 1/4.

Reference point - any place in a circuit from which measurements will be taken. As an example, one probe of a measurement instrument is placed on a conductor and the other probe is placed at other places in the circuit. All measurements are then taken from the first probe, or the reference point.

Relay - A electrical switch that uses an electromagnet. When electrical energy is applied to the coil, the electromagnet attracts a bar which either completes or breaks a connection. A solenoid is one type of relay.

Reluctance - A measure of opposition offered by a magnetic circuit to the setting up of flux.

Residual induction - The amount of reduction in a magnetized material when the force has been reduced to zero.

Residual magnetism - Magnetism that is left in the core of an electromagnet after the curcuit has been opened (the juice turned off).

Resistance - To hinder or impede or oppose electrical current. Resistance is a property of every type of material. Resistance determines how much current will be conducted by a material and how much heat will be given off. Resistance is measured in ohms. As an example, electricity has more difficulty flowing through brass than silver. Brass has more resistance than silver. The opposite of resistance is conductance.

Resistivity - See "specific resistance."

Resolution - (1) The amount of sharpness or accuracy of a picture or sound. The degree to which individual parts of a picture can be clearly seen. The degree to which individual sounds can be clearly heard. (2) The degree to which a system can tell the difference between details in a pattern. (3) The measure of the narrowest line width that can be transmitted and reproduced.

Semiconductor - (semi conductor) (1) A solid or liquid material that conducts and resists electrical energy. The amount of resistance is often determined by temperature. Examples of semiconductors are germanium, silicon, and arsenic. (2) An electronic device. These electronic devices or components contain semiconducting materials. Examples of semiconductor devices are transistors and computer "chips."

Series circuit - A circuit with only one path. Conductors, devices, and components are placed in a single line.

Series resistance - The amount of resistance due to resistors connected end to end or "series-connected" resistors.

Short - See "short-circuit," below.

Short-circuit - Electrical current flows through a set of conductors and/or devices in a path that it should not have. This happens when the resistance or impedence in the circuit is greater than in an unplanned path. As an example, suppose the insulation between the two wires in an electrical cord for a toaster wears out The two wires in the cord can now touch each other. Resistance between the two wires is lower than in the toaster. Current will therefore flow from one wire to the other where they are touching rather than through the toaster. This is a short-circuit.

Shorting switch - A type of switch that "splits" current flow when electrical energy reaches a predetermined level.

Shunt - (1) A connection or part connected in parallel with another part. (2) Low value resistor placed across terminals to increase the range of an ammeter. (3) In electrical circuits, a branch that is parallel with an external or line circuit.

Siemens - A measure for admittance. The symbol for siemens is "S."

Silicon - A nonmetallic element. Silicon is the second most common element on earth; oxygen is the first. It is used extensively by itself or mixed with other elements in electronic components or devices. Examples are "chips" and transistors.

Sintered - A material that is formed by first pressing metallic and nonmetallic powders into a desired shape. The material is then heated so that the particles cohere or stick to each other.

Solenoid - [so leh noid] A relay, coil, or an electromagnet, depending of use.

Specific gravity - Density of a substance as compared to the density the water at a constant temperature. A hydrometer is one type of device used to measure specific gravity. As an example, a hydrometer will tell us how dense (or packed with atoms) an electrolyte is in comparison to distilled water.

Specific resistance - The resistance of one cubic meter of a material. The unit of measure is ohm-meter.

Substrate - A supporting material (e.g., "board") on which the parts of a circuit are attached.

Symmetrical - (1) Both sides of an object or circuit are exactly alike. (2) Two parts of a circuit are balanced and have equal characteristics.

Terminal - The starting point(s) or ending point in a circuit.

Tesla - One weber per square meter of magnetic induction. This is equal to 10^8 maxwells of force on one square meter.

Thick film - A pattern made on ceramic substrate by applying thin layers of materials that are conductors and insulators. Thick films can be used to form conductors, resistors, and capacitors.

Toroid - [toe roid] (1) A geometric figure that looks like a donut. (2) Highly efficient type of coil where wire is tightly wound around a ring.

Transistor - A semiconductor device having three or more electrodes: emitter(s), base, and collector(s). Transistors were the first semiconductor replacements for vacuum tubes.

Valence - [vay' lence] Number that tells us how much and how well one atom can combine with another atom. Valence usually depends on the number of electrons and their arrangement around the nucleus of an atom. Valences of two atoms have to "match up" before they will combine. The valence of two hydrogen atoms match up with the valence of one oxygen atom; they can therefore combine to make up water.

Voltage drop - The difference between the voltage measured on one side of a device, such as a resistor, and the voltage on the other side. The potential difference across a device.

Voltaic cell - An early name for a particular type of battery. Voltaic cells produce electricity through an electrochemical reaction. This type of cell cannot be recharged.

Weber magnetic flux - The amount of magnetic flux that produces one volt of electromotive force in a circuit. One weber is equal to 10^8 power maxwells.

FIELD TEST VERSION - 8/23/84

Supplemental Instruction on

FRACTIONS

for Electronics Education

Student: _____ School: _____

This workbook provides a refresher on fractions. We would like to know how well this workbook helped you. If you do not understand or are unsure of something in the workbook, please let us know by writing your concern in this book. Your comment may be as simple as a question mark (?) next to a statement or problem. Turn this workbook in to your teacher or instructor when you are done with it; it will be returned to you later. What you do in this workbook will not affect your grade for the course.

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THE RURAL ELECTRONICS ACCORD PROJECT

Supplemental Instruction on

FRACTIONS

for Electronics Education

by

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Oregon State University

in cooperation with

Linn-Benton Education Service District
Linn-Benton Community College
Corvallis Schools, Greater Albany Schools, Lebanon Schools

August 1984

Fractions

Numbers such as 1/2, 11/12, 3/8, 8/9, and $\frac{1}{3}$ are called fractions. The number above the line is called a numerator and the one below the line is called the denominator.

$$1/2 = \frac{1}{2} = \frac{\text{numerator} = 1}{\text{denominator} = 2}$$

Exercise 1.1 Identify the numerator and the demoninator for each of the following fractions:

(1) 7/8 The numerator is which number? _____
The denominator is which number? _____

(2) 15/16 The numerator is which number? _____
The denominator is which number? _____

(3) 8/16 What is the numerator? _____
What is the denominator? _____

Answers: (1) numerator = 7; denominator = 8
(2) numerator = 15; denominator = 16
(3) numerator = 8; denominator = 16

A fraction means divide the numerator by the denominator. The symbol "/" means "divided by" or $\div$ in arithmetic.

1/2 means 1 divided by 2

OR $1 \div 2$

OR $2\overline{)\,1.0}$

OR 0.5

1/3 = 0.333

1/5 = 0.2

2/10 = 0.2

4/3 = $1\frac{1}{3}$ or 1.333

Exercise 1.2 Convert the following fractions into their decimal numbers (two decimal places):

(1) $\frac{6}{8}$ =

(2) 6/7 =

(3) 12/16 =

(4) 24/18 =

Answers: (1) 0.75; (2) 0.857 or 0.86; (3) 0.75; (4) 1.33

Converting a Fraction to Its Lowest Term

Items (1), (3) and (4) in Exercise 1.2, above, show numbers that are "bigger" than they need to be. For item (1), 6/8 is the same as 3/4. By dividing both "6" and "8" by 2, we get the fraction 3/4 (6/2 = 3 and 8/2 = 4). The fraction 3/4 is the lowest term for 6/8. If we wanted to get the decimal number for a fraction, 3 divided by 4 is a lot easier than 6 divided by 8. From a practical view, most people, including teachers, electronics technicians, and engineers, want fractions in their lowest terms.

Let's reduce the fraction 12/16 to its lowest term. First, divide 12 and 16 by 2.

$$\frac{12/2}{16/2} = \frac{6}{8}$$

Both 6 and 8, however, can still be divided by 2.

$$\frac{6/2}{8/2} = \frac{3}{4}$$

No other number can be divided into both 3 and 4 and still have them remain whole numbers (a number that is not a fraction or decimal number). Therefore 3/4 is the lowest term for 12/16.

Examples:

(1) Reduce 24/18 to its lowest term.

Divide by 2 $\quad \frac{24/2}{18/2} = \frac{12}{9}$

Divide by 3 $\quad \frac{12/3}{9/3} = \frac{4}{3}$

(2) Reduce 30/50 to its lowest term.

Divide by 2 $\quad \frac{30/2}{50/2} = \frac{15}{25}$

Divide by 5 $\quad \frac{15/5}{25/5} = \frac{3}{5}$

To reduce 12/16 to 3/4, we divided the fractions by 2 twice. Why not just divide 12 and 16 by 4? When reducing 24/18, we divided by 2 then by 3. Why not just divide 24 and 18 by 6? You could have done so and arrived at the same lowest terms. However, it may be easier to remember the following rules:

Rules: To reduce a fraction to its lowest term do the following in order:

(1) Try to divide both numerator and demoninator by 2 until you no longer get whole numbers.

(2) Then try dividing both numerator and denominator by 3, 5, or 7 until you no longer get whole numbers. (It may be possible to reduce a fraction with higher numbers, but let's not concern ourselves with that right now.)

Exercise 1.3 Reduce the following fractions to their lowest terms:

(1) 42/46 =

(2) 3/9 =

(3) 98/112 =

(4) 35/54 =

(5) 105/140 =

Answers: (1) 21/23; (2) 1/3; (3) 7/8 (4) 35/54 cannot be reduced further; (5) 3/4

Addition of Fractions

When adding fractions, the denominators (bottom numbers) must be the same. If the denominators are the same, then add the numerators (top numbers).

$$\frac{1}{2} + \frac{1}{2} = \frac{1+1}{2} = \frac{2}{2} = 1$$

$$2/4 + 1/4 = \frac{2+1}{4} = \frac{3}{4}$$

Exercise 2. Add the following pairs of fractions:

(1) 1/2 + 1/2 =

(2) 2/6 + 2/6 =

(3) 3/8 + 3/8 =

(4) 9/16 + 10/16 =

Answers: (1) 2/2 or 1; 4/6 or 2/3; 6/8 or 3/4; 19/16 or $1\frac{3}{16}$

If the denominators are different, then a common denominator must be found before the fractions can be added. That is, the denominators must be the same number or in common for both fractions.

1/3 + 4/3	Both fractions have the same denominator or a common denominator, the number 3.
1/4 + 2/3	The two fractions do not have the same denominator (the denominators are 4 and 3).

To find a common denominator, multiply the denominators. In the example, above, the denominators for the two fractions are different (4 and 3). Therefore, the denominators must be multiplied.

$$\frac{1}{4} + \frac{2}{3} = \frac{\quad}{4 \times 3} + \frac{\quad}{3 \times 4} =$$

Whatever is done to the dominator must be done to the numerator. That is, numerator for each fraction must be multiplied by the denominator for the other fraction. Continuing the example above:

$$\frac{1 \times 3}{4 \times 3} + \frac{2 \times 4}{3 \times 4} = \frac{3}{12} + \frac{8}{12} =$$

Finally, the two fractions can be added. You can add the two fractions because they have a common denominator. Completing the example:

$$\frac{3}{12} + \frac{8}{12} = \frac{3 + 8}{12} = \frac{11}{12}$$

When adding two fractions, the rule is:

1. Find the common denominator by multiplying the two bottom numbers.
2. Adjust each numerator (top numbers) by multiplying it by the denominator for the other fraction.
3. Add the two fractions.
4. Reduce the fraction to its lowest terms when possible.

Stated as a formula, the process is:

$$\frac{a}{b} + \frac{c}{d} = \frac{a \times d}{b \times d} + \frac{c \times b}{d \times b} = \frac{(a \times d) + (c \times b)}{(b \times d)}$$

Examples:

$$\frac{1}{2} + \frac{1}{3} = \frac{1 \times 3}{2 \times 3} + \frac{1 \times 2}{3 \times 2} = \frac{3}{6} + \frac{2}{6} = \frac{3 + 2}{6} = \frac{5}{6}$$

$$\frac{8}{7} + \frac{4}{9} = \frac{8 \times 9}{7 \times 9} + \frac{4 \times 7}{9 \times 7} = \frac{72}{63} + \frac{28}{63} = \frac{100}{63} = 1\,\frac{37}{63}$$

Adding three or more fractions is the same as adding two fractions. First, find the common denominator by multiplying <u>all</u> denominators. Then adjust <u>each</u> numerator by multiplying it by the same numbers as you used for each denominator.

$$\frac{1}{4} + \frac{2}{5} + \frac{3}{6} = \frac{1 \times 5 \times 6}{4 \times 5 \times 6} + \frac{2 \times 4 \times 6}{4 \times 5 \times 6} + \frac{3 \times 4 \times 5}{4 \times 5 \times 6}$$

$$= \frac{30}{120} + \frac{48}{120} + \frac{60}{120} = \frac{138}{120}$$

Dividing both the numerator <u>and</u> denominator by 2 equals $\frac{69}{60}$

Now dividing the numerator by the denominator equals $1\,\frac{9}{60}$

Exercise 3. Do the following additions and reduce to lowest terms:

(1) 3/4 + 9/5 =

(2) 4/7 + 4/9 =

(3) 7/8 + 5/6 =

(4) 1/5 + 2/7 =

(5) 1/4 + 1/5 =

(6) 1/4 + 1/5 + 1/7 =

(7) 4/9 + 8/6 + 5/7 =

(8) 2/9 + 5/11 + 5/9 =

(9) 3/7 + 4/7 + 5/7 =

(10) 11/9 + 3/8 + 3/4 =

Answers: (1) 51/20; (2) 64/63; (3) 41/24; (4) 17/35; (5) 9/20;
(6) 81/140; (7) 157/63; (8) 100/99; (9) 12/7; (10) 169/72

Evaluation: 9 - 10 correct = excellent
8 correct = good
7 correct = fair
less than 7 correct = try them again.

Subtraction of Fractions

Subtracting one fraction from another is similar to adding them.

$$2/3 - 1/3 = \frac{2 - 1}{3} = \frac{1}{3}$$

If the denominators are different, finding the common denominator and adjusting the numerators is similar to addition.

(1) Find the common denominator. Multiply the denominators with each other.

(2) Adjust the numerators. Multiply each numerator by the same number as multiplied in the denominator.

(3) Subtract (rather than add) the second numerator from the first.

Example: $2/3 - 1/4 =$

(1) Find the common denominator as you would when adding fractions.

$$\frac{2}{3} - \frac{1}{4} = \frac{}{3 \times 4} - \frac{}{4 \times 3} = \frac{}{12} - \frac{}{12} =$$

(2) Adjust the numerators as you would when adding fractions.

$$\frac{2 \times 4}{12} - \frac{1 \times 3}{12} = \frac{8}{12} - \frac{3}{12} =$$

(3) Subtract (not add) the second fraction from the first.

$$\frac{8 - 3}{12} = \frac{5}{12}$$

The formula for subtracting fractions is:

$$\frac{a}{b} - \frac{c}{d} = \frac{a \times d}{b \times d} - \frac{c \times b}{d \times b} = \frac{(a \times d) - (c \times b)}{(b \times d)}$$

Examples:

$$\frac{1}{2} - \frac{1}{3} = \frac{1 \times 3}{2 \times 3} - \frac{1 \times 2}{2 \times 3} = \frac{3}{6} - \frac{2}{6} = \frac{1}{6}$$

$$\frac{8}{7} - \frac{4}{9} = \frac{8 \times 9}{7 \times 9} - \frac{4 \times 7}{7 \times 9} = \frac{72}{63} - \frac{28}{63} = \frac{44}{63}$$

Exercise 4. Do the following subtractions:

(1) 1/4 - 1/5 =

(2) 3/4 - 2/5 =

(3) 1/4 - 1/6 =

(4) 1/3 - 2/5 =

(5) 4/5 - 1/3 =

(6) 3/7 - 1/7 =

(7) 4/9 - 2/5 =

Answers: (1) 1/20; (2) 7/20; (3) 1/12; (4) -1/15; (5) 7/12; (6) 2/7; (7) 2/45

Evaluations: 9 - 10 correct = excellent
8 correct = good
7 correct = fair
less than 7 correct = try them again

Multiplication of Fractions

Multiplication of fractions is often easier than adding or subtracting them. To multiply two fractions, just multiply the numerators, then multiply the denominators.

(1) Multiply the numerators.

$$\frac{1}{2} \times \frac{3}{4} = \frac{1 \times 3}{\quad} = \frac{3}{\quad}$$

(2) Multiply the denominators.

$$\frac{3}{2 \times 4} = \frac{3}{8}$$

Examples:

$$\frac{2}{3} \times \frac{4}{5} = \frac{2 \times 4}{3 \times 5} = \frac{8}{15}$$

$$\frac{1}{2} \times \frac{1}{3} = \frac{1 \times 1}{2 \times 3} = \frac{1}{6}$$

$$\frac{1}{4} \times \frac{1}{5} \times \frac{1}{6} = \frac{1 \times 1 \times 1}{4 \times 5 \times 6} = \frac{1}{120}$$

$$\frac{3}{4} \times \frac{2}{3} \times \frac{1}{5} = \frac{3 \times 2 \times 1}{4 \times 3 \times 5} = \frac{6}{60} = \frac{1}{10}$$

The formula for multiplying fractions is:

$$\frac{a}{b} \times \frac{c}{d} = \frac{a \times c}{b \times d}$$

Exercise 5. Do the following multiplications:

(1) 1/4 x 2/3 =

(2) 2/5 x 1/4 =

(3) 2/5 x 5/8 =

(4) 2/3 x 1/7 =

(5) 3/4 x 3/8 =

(6) 1/2 x 5/3 x 1/6 =

(7) 1/6 x 1/7 x 3/8 =

(8) 1/9 x 3/7 x 7/4 =

(9) 3/10 x 1/7 x 3/4 =

(10) 1/3 x 1/3 x 1/3 =

Answers: (1) 1/6; (2) 1/10; (3) 1/4; (4) 2/21; (5) 9/32; (6) 5/36; (7) 1/112; (8) 1/12; (9) 9/280; (10) 1/27

Evaluation: 9 - 10 correct = excellent
8 correct = good
7 correct = fair
less than 7 correct = try them again

Division of Fractions

Division of fractions is very similar to the multiplying them. However, we must first invert the second fraction, then multiply the two fractions. "Invert" means to place the number from the denominator on top and the number of the numerator on the bottom of the fraction. In other words, "change the places" of the numerator and denominator.

Example: $\frac{3}{4} \div \frac{1}{4} =$

(1) Invert the second fraction.

$$\frac{3}{4} \times \frac{4}{1} =$$

(2) Multiply the two fractions.

$$\frac{3 \times 4}{4 \times 1} = \frac{12}{4} = 3$$

The formula for division of fractions is:

$$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{a \times d}{b \times c} =$$

Examples:

$$\frac{1}{2} \div \frac{1}{3} = \frac{1}{2} \times \frac{3}{1} = \frac{1 \times 3}{1 \times 2} = \frac{3}{2} = 1\frac{1}{2}$$

$$\frac{4}{5} \div \frac{3}{7} = \frac{4}{5} \times \frac{7}{3} = \frac{4 \times 7}{5 \times 3} = \frac{28}{15} = 1\frac{13}{15}$$

Exercise 6. Do the following divisions:

(1) $1/4 \div 3/4 =$

(2) $1/5 \div 1/6 =$

(3) $1/6 \div 2/5 =$

(4) $2/7 \div 2/9 =$

(5) $3/11 \div 3/9 =$

(6) $2/3 \div 4/7 =$

(7) $1/5 \div 1/5 =$

(8) $2/3 \div 3/2 =$

Answers: (1) 1/3; (2) 6/5; (3) 5/12; (4) 9/7; (5) 9/11; (6) 7/6; (7) 1; (8) 4/9

Evaluation :

7-8 correct = excellent
6 correct = good
5 correct = fair
less than 4 correct = try them again

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Supplemental Instruction on

SCIENTIFIC NOTATION

for Electronics Education

Student: _____ School: _____

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Scientific Notation

It is not too difficult to read a number like 100 or 1000. However, when you have many zeros in the number, i.e., 100000000, it is not easy to recognize its value. There is another way to write or think of these numbers.

Look at the following examples:

10 can be expressed as 10^1

100 = 10 x 10, which can be express as 10^2

1000 = 10 x 10 x 10, which can be express as 10^3

10000 = 10 x 10 x 10 x 10, which can be express as 10^4

1000000 = 10 x 10 x 10 x 10 x 10 x 10, which can be express as 10^6

The number 10^2 is called "ten to the second power." The number 10 is the base, and 2 is the power or exponent. The number of the power is the number of zeros.

To convert a number to its right power, you count the number of zeros after 1.

Examples:

$100 = 10^2$ (2 zeros after 1)

$10000 = 10^5$ (5 zeros after 1)

$10000000 = 10^7$ (7 zeros after 1)

$100000000000 = 10^{11}$ (11 zeros after 1)

and

$1 = 10^0$ (0 zeros after 1)

Exercise 1.1. Convert following numbers to powers of 10:

1) 100,000 =

2) 1,000,000,000,000 =

3) 1 =

4) 10 =

5) 10,000,000 =

To convert a number from its power or exponential form, add zeros to the base number. The number of zeros depends on the value of the exponent or power. This is also called, "moving the decimal point to the right."

Examples:

(1) For the number 10^2

First write the number 1.0

Then move the decimal point 2 places to the right

------> 1 00. = 100
|__|

2 places

(2) For the number 10^6

First write the number 1.0

Then move the decimal point 6 places to the right

------> 1 000000. = 1,000,000
|_____|

6 places

(3) For the number 10^4

First write the number 1.0

Then move the decimal point 4 places to the right

------> 1 0000. = 10,000
|____|

4 places

Exercise 1.2. Convert the following numbers from their exponential form to their regular form (i.e., $10^2 = 100$):

6) $10^7 =$

7) $10^2 =$

8) $10^0 =$

9) $10^8 =$

10) $10^6 =$

Answers: 1) 10^5; 2) 10^{12}; 3) 10^0; 4) 10^1; 5) 10^7;

6) 10,000,000; 7) 100; 8) 1; 9) 100,000,000 10); 1,000,000

9 correct = good
8 correct = fair
less than 8 correct = try them again

Negative Power of Ten

Negative powers of ten such as 10^{-1} is called, "ten to the minus one power." These negative exponents are used to represent numbers that are less than one.

10^{-1} can be expressed as $(1/10)^1$ or $1/10 = 0.1$

10^{-2} can be expressed as $(1/10)^2$ or $1/100 = 0.01$

10^{-4} can be expressed as $(1/10)^4$ or $1/10000 = 0.0001$

10^{-6} can be expressed as $(1/10)^6$ or $1/1000000 = 0.000001$

To convert a negative power of ten to a decimal number, first write "1.0". Then move the decimal point to the left. The number of places to the left depends on the value of the exponent.

Examples:

(1) For the number 10^{-1}

First write the number 1.0

Then move the decimal point to the left 1 place

-----> .1 0 = 0.1
|_|

1 place

(2) For the number 10^{-5}

Write the number 1.0

Then move the decimal point five places to the left

----->.00001 0 = 0.00001
|_____|

5 places

(3) For the number $1:^{-2}$

Write the numbe 1.0

Then move the decimal point 2 places to the left

-----> .01 0 = 0.01
|__|

2 places

Inversely, to convert a number that is less than 1 to a negative power, move the decimal point to the right until you get 1.0. Then count how many places it has been moved to the right. The number of places will be the value of the exponent.

Examples:

(1) For the number 0.1

Move the decimal point to the right until you get 1.0

0 1.
|_|

1 place

The exponential form of the number is 10^{-1}

(2) For the number 0.001

Move the decimal point to the right until you get 1.0

0 001.
|___|

3 places

The exponential form of the number is therefore 10^{-3}

(3) For the number 0.000000001

Move the decimal point to the right

0 000000001.
|_____|
9 places

The exponential form of the number is 10^{-9}

Reminder: For <u>negative</u> powers move the decimal point to the right.
For <u>positive</u> powers move the decimal point to the left.

Exercise 2.1 Convert the following numbers to powers of 10.

1) 0.01 =

2) 0.1 =

3) 0.00001 =

4) 0.0000000001 =

5) 1,000,000 =

Exercise 2.2. Convert the following exponential numbers:

6) 10^{-2} =

7) 10^{-6} =

8) 10^{-5} =

9) 10^{9} =

10) 10^{6} =

Answers: 1) 10^{-2}; 2) 10^{-1}; 3) 10^{-5}; 4) 10^{10}; 5) 10^{6}
6) 0.01; 7) 0.000001; 8) 0.00001; 9) 0.000000001;
10) 1,000,000

Evaluation : 9 - 10 correct = excellent
8 correct = good
7 correct = fair
less than 7 correct = try them again

With the ten powers or exponent method, we may express large numbers in short form without losing accuracy. This method is called scientific notation. You can use powers of ten to state values in various ways.

Examples:

(1) 625,000 = 625000.

= 625.000 = 625.0×10^3

3 places

= 62.5000 = 62.5×10^4

4 places

= 6.25000 = 6.25×10^5

5 places

= .625000 = 0.625×10^6

6 places

(2) 0.0014 = 0 0.014 = 0.014×10^{-1}

1 place

= 0 00.14 = 0.14×10^{-2}

2 places

= 0 0014. = 14×10^{-4}

4 places

.ff

(3) 1.62×10^3 = 1 620. = 1620

3 places

(4) $1.74 \times 10^{2} = 1\ 74.0 = 174$

2 places

(5) $1.62 \times 10^{-3} = 0.001\ 62 = 0.00162$

3 places

(6) $1.72 \times 10^{-2} = 0.01\ 72 = 0.0172$

2 places

(7) $1.9999 \times 10^{-5} = 0.00001\ 9999 = 0.000019999$

5 places

$= 1\ 9.999 = 19.999 \times 10^{-5+(-1)} = 19.999 \times 10^{-6}$

1 place

The ability to convert numbers to powers or powers to number is very important for you in electronics.

Exercise 3.1. Convert the following numbers to scientific notations:

1) 0.015 =
2) 627,000 =
3) 0.731 =
4) 0.000731 =
5) 0.0000332 =
6) 4,000,000 =
7) 28,000,000 =
8) 0.0000036 =
9) 180,000 =
10) 0.023 =

Exercise 3.2. Convert the following numbers from scientific notation:

11) 12.6×10^{-5} =
12) 1.2×10^{-5} =
13) 7.5×10^{1} =
14) 4.7×10^{0} =
15) 5.6×10^{u4} =
16) 1.2×10^{2} =
17) 1.2×10^{-3} =
18) 1.56×10^{3} =
19) 3.9×10^{6} =
20) 2.2×10^{-2} =

Answers: 1) 1.5×10^{-2}; 2) 6.27×10^{5}; 3) 7.31×10^{-1};
4) 7.31×10^{-5}; 5) 3.32×10^{-5}; 6) 4.0×10^{6};
7) 2.8×10^{7}; 8) 3.6×10^{-6}; 9) 1.8×10^{5};
10) 2.3×10^{-2};
11) 0.000126; 12) 0.000012; 13) 75; 14) 4.7; 15) 56,000
16) 120; 17) 0.0012; 18) 1,560; 19) 3,900,000; 20) 0.022

Evaluation:
19 -20 correct = excellent
17 -18 correct = good
16 -17 correct = fair
less than 16 correct = try them again

Multiplying, and Dividing

Multiplying and dividing in scientific notation is very easy. First, you solve for the significant figures, then the powers of ten.

Rule:

To multiply two scientific notation numbers

1) multiply two significant numbers
2) add two exponent numbers
3) connect the new significant number and exponent with an "x"

Example 1: $(6.2 \times 10^3) \times (1.5 \times 10^2) =$

1) Multiply the two significant numbers

   $6.2 \times 1.5 = 9.3$

2) Add the two exponent numbers

   $10^3 \times 10^2 = 10^{3+2} = 10^5$

3) Connect the new significant number and exponent

   The answer is 9.3×10^5

Example 2: $(6.2 \times 10^3) \times (1.5 \times 10^{-2}) =$

1) Significant numbers: $6.2 \times 1.5 = 9.3$
2) Exponents: $10^3 \times 10^{-2} = 10^{3+(-2)} = 10^1$
3) The answer is 9.3×10^1 or 93

Example 3: $(1.5 \times 10^{-1}) \times (1.5 \times 10^{3}) =$

1) Significant numbers: $1.5 \times 1.5 = 2.25$

2) Exponents: $10^{-1} \times 10^{3} = 10^{-1 + 3} = 10^{2}$

3) Connecting: 2.25×10^{2}

Example 4: $(6.5 \times 10^{-4}) \times (2.5 \times 10^{-2}) =$

1) $6.5 \times 2.5 = 16.25$

2) $10^{-4} \times 10^{-2} = 10^{-4 + (-2)} = 10^{-6}$

3) The answer is 16.25×10^{-6} or 1.625×10^{-5}

Rule:

To divide two scientific notation numbers

1) divide the significant number for the numerator by the significant number for the denominator
2) substract the exponent number of the denominator from the exponent of the numerator
3) connect the new significant number and new exponent with "x"

Example 1: $\dfrac{6.2 \times 10^{14}}{3.1 \times 10^{6}}$

1) Divide the two significant numbers

   6.2 divided by 3.1 = 2

2) Subtract the bottom exponent number from the top

   10^{6} subtracted from $10^{14} = 10^{(14 - 6)} = 10^{8}$

3) The answer is 2×10^{8}

Example 2: $\dfrac{6.2 \times 10^{14}}{3.1 \times 10^{-3}}$

1) Significant numbers: 6.2 divided by 3.1 = 2.0
2) Exponents: 10^{-3} subtracted from $10^{14} = 10^{14 - (-3)} = 10^{17}$
3) Combining, the answer is 2×10^{17}

Example 3: $\dfrac{9.3 \times 10^{-3}}{3.1 \times 10^{2}}$

1) Significant numbers: $9.3/3.1 = 3.0$

2) Exponents: $10^{-3}/10^{2} = 10^{-3-2} = 10^{-5}$

3) Combining: 3×10^{-5}

Exercise 4. Perform the following computations; give answer in scientific notations when appropriate:

1) $(1.3 \times 10^{3}) \times (2.0 \times 10^{2}) =$

2) $(4.9 \times 10^{2}) \times (1.8 \times 10^{-6}) =$

3) $(4.9 \times 10^{-4}) \times (1.8 \times 10^{4}) =$

4) $(5.6 \times 10^{-3}) \times (1.8 \times 10^{-3}) =$

5) $(5.6 \times 10^{-3}) \times (2.3 \times 10^{3}) \times (1.2 \times 10^{4}) =$

6) $(1.8 \times 10^{4}) \div (9.0 \times 10^{3}) =$

7) $(8.1 \times 10^{-3}) \div (9.0 \times 10^{3}) =$

8) $(4.7 \times 10^{6}) \div (2.35 \times 10^{-2}) =$

9) $(4.7 \times 10^{-2}) \div (2.35 \times 10^{6}) =$

10) $(1.6 \times 10^{7}) \times (3.0 \times 10^{3}) \div (2.4 \times 10^{-3}) =$

Answers :

1) 3.6×10^{5}; 2) 8.88×10^{-4}; 3) 8.88;

4) 10.08×10^{-6}; 5) 1.546×10^{5}; 6) 2;

7) .09; 8) 2×10^{8}; 9) 2×10^{-8}; 10) 2×10^{13}

Evaluation:
9 -10 correct = excellent
7- 8 correct = good
7 correct = fair
less 7 than correct = try them again

There are a few values in electronics that are used so frequently that it is convenient to use "nicknames" for them. The Metric System uses a "prefix" before the unit of measure to tell what the power or multiplier is.

Metric Prefixes

Prefix	Prefix Symbol	Scientific notation	Decimal	name
mega	M	$\times 10^{6}$	1,000,000	million
kilo	K	$\times 10^{3}$	1,000	thousand
milli	m	$\times 10^{-3}$	0.001	thousandth
micro	u	$\times 10^{-6}$	.000001	millionth
nano	n	$\times 10^{-9}$	.000000001	billionth
pico	p	$\times 10^{-12}$	.000000000001	trillionth

Notice that the powers of ten are always multiples of 3 (10^{6}, 10^{3}, 10^{-3}, 10^{-6}, etc.). When using powers of ten in the Matrix System, the exponent should multiples of three.

In electronics, we often use the Metric System prefixes to represent powers of ten. As an example, 1K volts (or 1KV) is used in place of 1×10^{3} volts or 1,000 volts. We also use 2 mA (milliamperes) to represent 2×10^{-3} amperes or 0.002 amperes . Therefore, you should familar with the Prefix System.

Examples: ("A" means amperes, the unit of current; "V" represents volts.)

1) 4.7×10^{-7} Amp = 47×10^{-6} Amp = 47 uA

2) 3.2×10^{4} volts = 32×10^{3} volts = 32 KV

3) 32×10^{6} volts = 32 MV

4) 0.002 amp = 2×10^{-3} amp = 2 mA

5) 0.0004 amp = 0.4×10^{-3} amp = 0.4 mA

6) 0.09 amp = 90×10^{-3} = 90 mA

Exercise 5.1. Convert the following numbers to scientific notation:

1) 61 K =

2) 3.3 K =

3) 47 M =

4) 39 K =

5) 3 m =

6) 3 u =

7) 14 n =

8) 32 p =

9) 66 M =

10) 14 m =

Exercise 5.2. Convert the following numbers to Metric Prefixes:

11) 3×10^{6} =

12) 2×10^{-6} =

13) 33×10^{-3} =

14) 38×10^{3} =

15) 45×10^{-9} =

16) 12×10^{-12} =

17) 45×10^{-8} =

18) 47×10^{-2} =

19) 22×10^{4} =

20) 22×10^{2} =

Answers:

1) 61×10^{3}; 2) 3.3×10^{3}; 3) 47×10^{6}; 4) 39×10^{3};

5) 3×10^{-3}; 6) 3×10^{-6}; 7) 14×10^{-9}; 8) 32×10^{-12};

9) 66×10^{6}; 10) 14×10^{-3}; 11) 3 M; 12) 2 u;

13) 33 m; 14) 38 K; 15) 45 n; 16) 12 p; 17) 0.45 n or 450 u;

18) 470 m; 19) 220 k; 20) 2.2

Evaluation:
19 - 20 correct = excellent
17 - 18 correct = good
15 - 16 correct = fair
less than 15 correct = try them again

FIELD TEST VERSION - 8/23/84

Supplemental Instruction on

EQUATIONS

for Electronics Education

Student: _____ School: _____

This workbook provides a refresher on equations. We would like to know how well this workbook helped you. We encourage you to write in this workbook. If you do not understand or are unsure of something in the workbook, please let us know by writing your concern in this book. Your comment may be as simple as a question mark (?) next to a statement or problem. Turn this workbook in to your teacher or instructor when you are done with it; it will be returned to you later. What you do in this workbook will not affect your grade for the course.

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EQUATIONS

for Electronics Education

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Department of Vocational and Technical Education
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August 1984

Equations

Suppose you wish to know how many miles per gallon (MPG) your car got on its last trip. You probably know that it is just a matter of dividing the number of miles you drove by the number of gallons of gas you used. You can show this with the following formula:

$$\text{MPG} = \frac{\text{miles driven}}{\text{gallons of gas used}}$$

If you drove 500 miles and used 20 gallons of gas, miles per gallon for the trip was:

$$\text{MPG} = \frac{\text{miles driven}}{\text{gallons used}} = \frac{500 \text{ miles}}{20 \text{ gallons}} = 25 \text{ miles per gallon}$$

A formula such as $\text{MPG} = \frac{\text{miles driven}}{\text{gallons used}}$ is called an <u>equation.</u>

There are three terms in this equation: (1) MPG, (2) miles driven, and (3) gallons used. Each term is a different part of the equation.

An equation always has two sides. The terms on each side of an equation are connected with an equal sign (=) to show their relationship. The relationship between terms on the two sides of an "=" is similar to a balance beam or scale.

$$\text{MPG} \quad = \quad \frac{\text{miles driven}}{\text{gallons used}}$$

The purpose of an equation is to show the relationship among terms. For example, the equation $\text{MPG} = \frac{\text{miles driven}}{\text{gallons used}}$ shows the relationship of MPG

to miles driven and gallons used. If you know the values for any two terms, you can figure out the value of the third one. More about that later.

In math, we usually use letters such as A, B, C, X, Y, Z to represent terms. As an example:

$$X = \frac{Y}{Z}$$

The equation $X = Y/Z$ is the formula for $MPG = \frac{\text{miles driven}}{\text{gas used}}$ if the letters X, Y and Z had the following meanings:

X = MPG
Y = miles driven
Z = gallons of gas used

Here is another problem. If you bought Z pounds of apples, and they cost you Y cents, how much did one pound of apples cost (X)? Expressed as an equation:

$$\text{cost per pound} = \frac{\text{your cost}}{\text{pounds of apples}} \quad \text{OR} \quad X = \frac{Y}{Z}$$

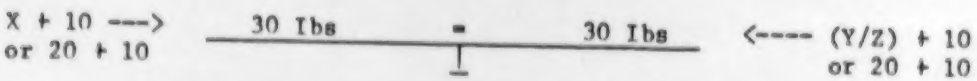
As we said earlier, an equation is just like a scale. If $Y/Z = 20$ pounds (lb.), then X must be 20 pounds.

Both sides of an equation must be in balance. What if we add ten pounds to one side of the scale? We must also add ten pounds to the other side of the scale so that both sides will be balanced.

Left side: $X \xrightarrow{\text{add 10 lbs}} X + 10$

Right side: $Y/Z \xrightarrow{\text{add 10 lbs}} Y/Z + 10$

Result:



If we substract 10 pounds (lb.) from one side of the equation, we must subtract 10 pounds from the other side.

Left side: X —(minus 10 lbs)—> X - 10

Right side: Y/Z —(minus 10 lbs)—> Y/Z - 10

Result:

X - 10 ----> or 20 - 10 | 10 lbs = 10 lbs | <---- (Y/Z) - 10 or 20 -10

If we multiply one side of the equation by 2, we must multiply the other side by 2.

Left side: X —(times 2)—> 2X

Right side: Y/Z —(times 2)—> 2(Y/Z)

Result:

2X ----> or 2 x 20 | 40 lbs = 40 lbs | <---- 2(Y/Z) or 2 x 20

If we divide one side of the equation by 2, we must divide the other side by 2.

left side: X —(divided by 2)—> X/2

right side: Y/Z —(divided by 2)—> (Y/Z)/2

result:

X/2 ----> or 20 ÷ 2 | 10 lbs = 10 lbs | <---- (Y/Z)/2 or 20 ÷ 2

From these examples, we know that we may operate (add, substract, multiply or divide) on one side of an equation as long as we do the same thing to the other side of the equation. Operating on both sides of an equation in the same way will <u>not</u> change its balance. The value of the term on the left side of "=" must always equal the value on the right side.

Exercise 1. Lets try balancing these equations:

(1) If X Y/Z and we add 50 to Y/Z, what must we do to X?

(2) If A/B = C and we multiply C by D, what must we do to A/B?

(3) If R = S/T and we divide S/T by S, what must we do to R?

(4) If $J = \frac{K + L}{M}$ and we multiply J by M, what must we do to the other side of the equation?

(5) If E = F and you subtract G from E, what must we do to F?

Answers: (1) add 50 to X; (2) multiply A/B by D; (3) divide R by S; (4) multiply $\frac{K + L}{M}$ by M; (5) subtract G from F.

Evaluation: 5 correct = excellent
4 correct = good
Correct the execises you missed. If you ca not, ask your instructor for help.

There is another feature to equations. If equation $X = \frac{Y}{Z}$ is in is balance, then the follwing two equations are also balanced:

$XZ = Y$ $\qquad\qquad$ $Z = \frac{Y}{X}$

(XZ = X times Z)

How can all three equations be correct? Let us look at the following examples:

If $X = \frac{Y}{Z}$ and we multiply both sides by Z:

Left side: $X \xrightarrow{\text{times Z}} XZ$ (X times Z)

Right side: $Y/Z \xrightarrow{\text{times 2}} (Y/Z) \times Z = \frac{Y}{Z} \times \frac{Z}{1} = Y$

Result: $XZ = Y$

If $X = \frac{Y}{Z}$ and we multiply both sides by $\frac{Z}{X}$

Left side: $X \xrightarrow{\text{multiplied by } \frac{Z}{X}} \frac{XZ}{X} = Z$

Right side: $\frac{Y}{Z} \xrightarrow{\text{multiplied by } \frac{Z}{X}} \frac{YZ}{XZ} = \frac{Y}{X}$

Result: $Z = \frac{Y}{X}$

It does not matter whether $X = Y/Z$, $Y = XZ$ or $Z = Y/Z$; they only show the relationship among X, Y and Z. Therefore, once you know the values of any two terms, you can easily figure out the value of the third term.

Example: For the equation $X = Y/Z$

(1) If $X = 2$, $Y = 1$
then , $Z = Y/Z = 1/2$ 0.5

(2) If $X = 2$, $Z = 3$
then, $Y = XZ = 2 \times 3 = 6$

(3) If $Y = 2$, $Z = 1$
then, $X = Y/Z = 2/1 = 2$

Ohm's Law

An application of equations in electronics is using "Ohm's Law." Ohm's Law shows the relationship among voltage, current and resistance. The formula or equation is:

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}}$$

Usually, R means resistance, E means voltage, and I means current. Using these abbreviations, Ohm's Law is indicated as:

$$R = \frac{E}{I}$$

The equation can therefore be shown as:

$$E = IR$$

or

$$I = E/R$$

A simple tool for memorizing the three equations is an Ohm's Law pie.

*** MEMORIZE THIS ***

(1) First draw a "T." Then place the letters in the T in alphabetic order: E, I, R.

(2) To solve for voltage (E), simply put a finger on the E, and you see I and R next to each other or E = IR.

(3) To solve for current (I), cover the I, and you see E over R or $I = \frac{E}{R}$

(4) To solve for resistance (R), cover the R, and you see E over I or $R = \frac{E}{I}$

Examples:

1) If we know that voltage across a resistor is 20 volts , and current going through the resistance is 10 amperes, then the resistance of the resistor:

   $R = E/I = 20/10 = 2$ (ohms)

2) If we know that current is 5 amperes and resistance is 10 ohms then voltage is:

   $E = IR = 5 \times 10 = 50$ (volts)

3) If voltage is 2K volts and resistance is 500 ohms, then the current is:

   $I = E/R = 2000/500 = 4$ (amps)

Exercise:

IF an equation is X = Y/Z and:

(1) Y = 3, Z = 2, what is X?

(2) X = 1, Y = 2, what is Z?

(3) X = 1, Z = 2, what is Y?

(4) Y = 4, X = 2, what is Z?

(5) X = 3, Y = 4, what is Z?

Ohm's law is R = E/I. If:

(6) Voltage = 6 volts, current = 3 amps, what is the resistance?

(7) Voltage = 3 volts, resistance = 2 ohms, what is the current?

(8) Resistance = 2 ohms, current = 3 amps, what is the voltage?

(9) Voltage = 3 mV, current = 6 mA, what is the resistance?

(10) Voltage = 6 KV, resistance = 3 M ohms, what is the current?

Answers: (1) 1.5; (2) 2; (3) 2; (4) 2; (5) 4/3 or 1.3333;
(6) 2 ohms; (7) 1.5 amps; (8) 6 volts; (9) 0.5 ohm;
(10) 2 milliamps.

Evaluation:
9 - 10 correct = excellent
8 correct = good
7 correct = fair
less than 7 correct = try them again

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Supplemental Instruction on

TWO-VARIABLE EQUATIONS

for Electronics Education

Student: _____ School: _____

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TWO-VARIABLE EQUATIONS

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Two-Variable Equations

If you know the values for two terms of equations in the form of X = Y/Z, Y = XZ or Z = Y/X, you can figure out the value of the third term. As an example, you have measured 100 volts and 10 amps in a circuit. How much resistance is in the circuit? From Ohm's Law, we know that the relation between voltage (E), current in amperes or amps (I) and resistance in ohms (R) is:

$$E = IR$$

The equation may also be stated as:

$$R = E/I$$

If we insert the known values, the equations becomes:

$$R = \frac{100}{10} \qquad \begin{matrix}(100 \text{ volts}) \\ (10 \text{ amperes})\end{matrix}$$

We now have two known terms and one unknown term or variable. Completing our solution, the amount of resistance in the circuit is 10 ohms.

The term with the unknown value is called a variable. We have been discussing equations with one variable. However, we are not limited to solving problems with only one unknown. We can also solve problems with with two variables or unknown values.

For example, if you bought two pounds of oranges and three pounds of apples for $2.80, what would the price of each be? In this case there are two terms with unknown values (variables): (1) the price of oranges and (2) the price of apples. If we assume that one pound of oranges costs X dollars and one pound of apples costs Y dollars, we could state the relationship between the two variables and the total cost ($2.80) as follows:

The cost of 2 pounds of oranges is 2X

The cost of 3 pounds of apples is 3Y

Therefore, $2X + 3Y = 2.80$

We needed only <u>one</u> equation to solve a problem with <u>one</u> unknown term. On the other hand, we will need <u>two</u> equations to solve a problem with <u>two</u> unknown terms or variables. Let us suppose that your friend, Jane, bought one pound of oranges and four pounds of apples for $2.90. Her purchase may be described by the following equation:

$$X + 4Y = 2.90$$

Combining both your equation and Jane's equation, it is now possible to figure out the price of each fruit as follows:

$2X + 3Y = 2.80$ (your equation)

$X + 4Y = 2.90$ (Jane's equation)

1) First we put Jane's equation on a balance scale.

2) You bought two pounds of apples or 2X, and she bought one pound or 1X. If we multiply both sides of her equation by 2, we see the following:

Left side: $X + 4Y$ ——times 2——> $2 \times (X + 4Y) = 2X + 8Y$

Right side: 2.90 ——times 2——> $2 \times 2.90 = 5.80$

Result: $2X + 8Y = 5.80$

3) We now subtract your equation from Jane's equation.

$$\begin{array}{rl} 2X + 8Y = 5.80 & \text{(Jane's equation)} \\ -\ 2X + 3Y = 2.80 & \text{(minus your equation)} \\ \hline 0X + 5Y = 3.00 & \text{(0 x X = 0)} \\ 5Y = 3.00 & \text{(divide both sides by 5)} \\ Y = 0.60 & \end{array}$$

The price for one pound of apples is $0.60.

4) Now that we know the price of apples, insert the price of apples into your equation, and solve for X, the remaining variable or unknown.

$$\begin{array}{rll} 2X + 3Y = 2.80 & \leftarrow\!\!\!\!\!\!\!\!- & \text{(your equation)} \\ 2X + 3(.6) = 2.80 & & \text{(replacing Y with \$0.60)} \\ 2X + 1.80 = 2.80 & & \text{(subract 1.80 from both sides)} \\ 2X = 1.00 & & \text{(divide both sides by 2)} \\ X = 0.50 & & \end{array}$$

The price for one pound of oranges is $0.50.

5) To check your equation, insert all the "knowns" into the variables:

$$\begin{array}{r} 2X + 3Y = 2.80 \\ 2(.50) + 3(.60) = 2.80 \\ 1.00 + 1.80 = 2.80 \end{array}$$

Rules:

(1) To solve problems with unknown terms, you need as many equations as there are variables. That is, you need one equation if you have one unknown term. In order to solve a two variable problem, you will need two equations.

(2) For a two equation problem, your first goal is to cancel one of the variables.

Method to Cancel One of the Variables

(1) Multiply both sides of one equation by a number (such as 2) so that one variable in both equations will have the same value.

In the preceding example, Jane's equation was multiplied by 2:

$2 \times (X + 4Y) = 2 \times 2.90$

$2X + 8Y = 5.80$ (Jane's new equation)

The reason for multiplying Jane's equation by 2 was to get her variable X to equal the 2X in your equation.

$2X + 3Y = 2.80$ (your equation)

$2X + 8Y = 5.80$ (Jane's new equation)

(2) Subtract one equation from the other. This will cancel one variable. Then one unknown can be solved with one equation.

$$\begin{array}{rrcll} & 2X + 8Y & = & 5.80 & \text{(Jane's new equation)} \\ - & 2X + 3Y & = & 2.80 & \text{(your equation)} \\ \hline & 0X + 5Y & = & 3.00 & \text{(divide by 5)} \\ & Y & = & .60 & \end{array}$$

Example:

$$6X - 2Y = 6 \qquad \text{(first equation)}$$
$$2X + 3Y = 13 \qquad \text{(second equation)}$$

(1) Multiply the second equation by 3:

$$3 \times (2X + 3Y) = 3 \times 13 \qquad \text{(multiply by 3)}$$
$$6X + 9Y = 39 \qquad \text{(new second equation)}$$

(2) Subtract the first equation from the second equation (new equation):

$$\begin{array}{rl} 6X + 9Y = 39 & \text{(new second equation)} \\ -(6X - 2Y) = 6 & \text{(first equation)} \\ \hline 0X + 11Y = 33 & \text{(cancelled variable X)} \\ Y = 3 & \text{(solution for Y)} \end{array}$$

(3) Solve the remaining variable by substituting for Y:

$$\begin{array}{rl} 6X - 2Y = 6 & \text{(orginial second equation)} \\ 6X - (2 \times 3) = 6 & \text{(substituting 3 for Y)} \\ 6X - 6 = 6 & \text{(add 6 to each side)} \\ 6X - 6 + 6 = 6 + 6 & \\ 6X = 12 & \text{(divide each side by 6)} \\ X = 2 & \end{array}$$

(4) To check the solutions for X and Y:

$$\begin{array}{rl} 6X - 2Y = 6 & \text{(original second equation)} \\ 6(2) - 2(3) = 6 & \text{(substituting for X and Y)} \\ 12 - 6 = 6 & \\ 6 = 6 & \end{array}$$

Exercise: Find the values for the two unknown terms or variables:

(1) $2X + 3Y = 11$
$X + Y = 4$

(2) $3X + Y = 2$
$2X + 3Y = 16$

(3) $4X + Y = 9$
$2X - Y = 3$

(4) $-5X + Y = -3$
$4X + 3Y = 10$

5) $X + 5Y = 6$
$3X + 4Y = 7$

Answers: (1) $X = 1, Y = 3$; (2) $X = 2, Y = 4$; (3) $X = 2, Y = 1$;
(4) $X = 1, Y = 2$; (5) $X = 1, Y = 1$.